Research activities at Vienna University of Technology on promotion of Renewables and decentralised energy supply

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Energy Economics Group,
Vienna University of Technology

Method of approach

- Starting from an energy-economic assessment of decision-making for purchasing energy services:

$$S = E\,\eta(T) \qquad S = f(Y, p_s, WTP(s))$$

- Modeling dynamic processes based on technological learning, cost resource curves of potentials and policy measures

- Combing bottom-up (technical) modeling with top-down (econometric) analyses

Major research areas

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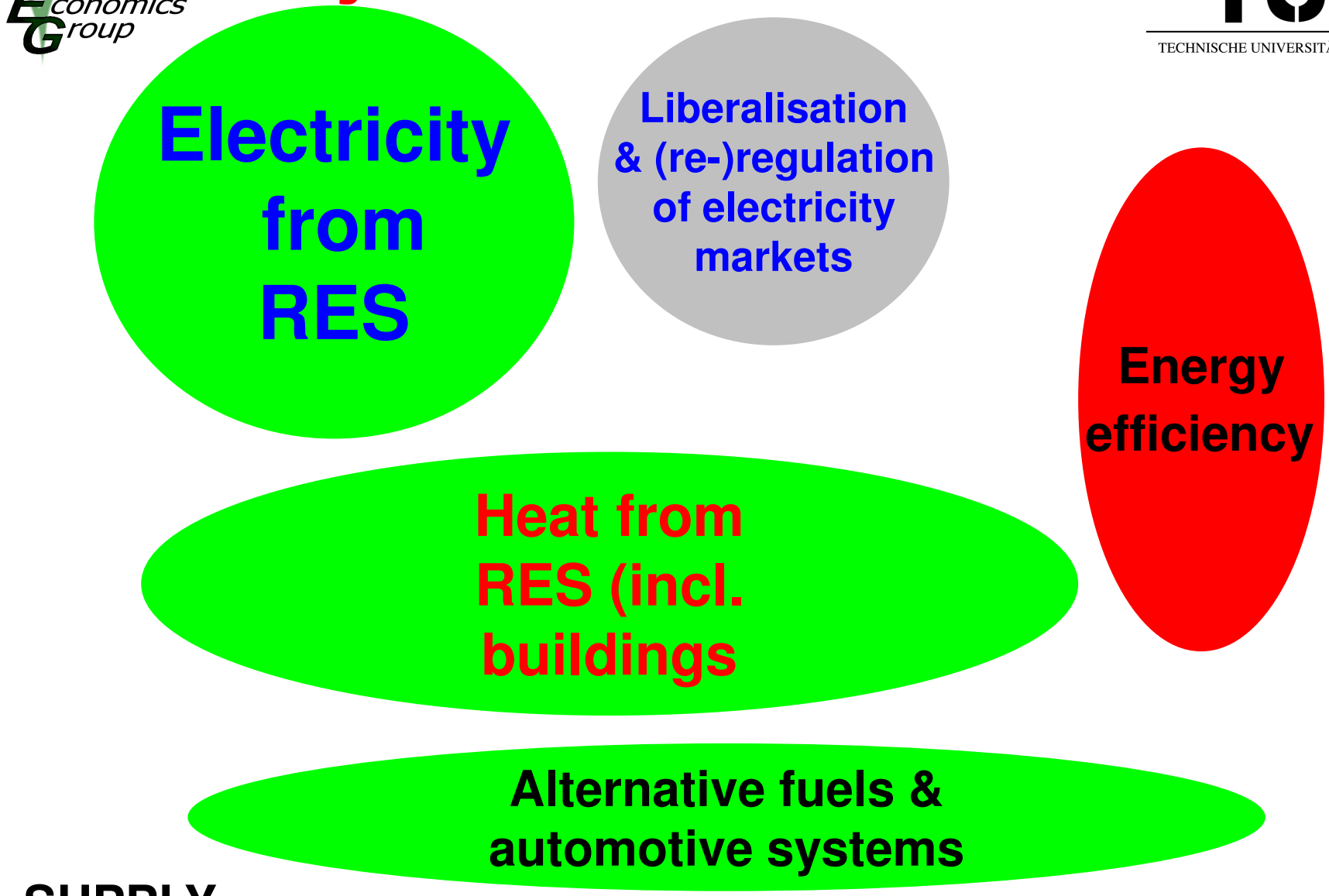


SURVEY

1. Introduction mission / research focuses
2. Liberalised vs regulated electricity markets
3. Promotion of renewables for electricity & heat
4. Promotion of alternative fuels and alternative automotive systems in transport
5. Outlook

1. Mission statement

- Our current standard of living – all goods and services we enjoy – is based on the consumption of energy

- However, this system is currently not sustainable. Renewable energy sources as well as more efficient and more careful ways to use energy are cornerstones in converting our economy into a sustainable system

- The objective of the EEG is, to contribute significantly to this process

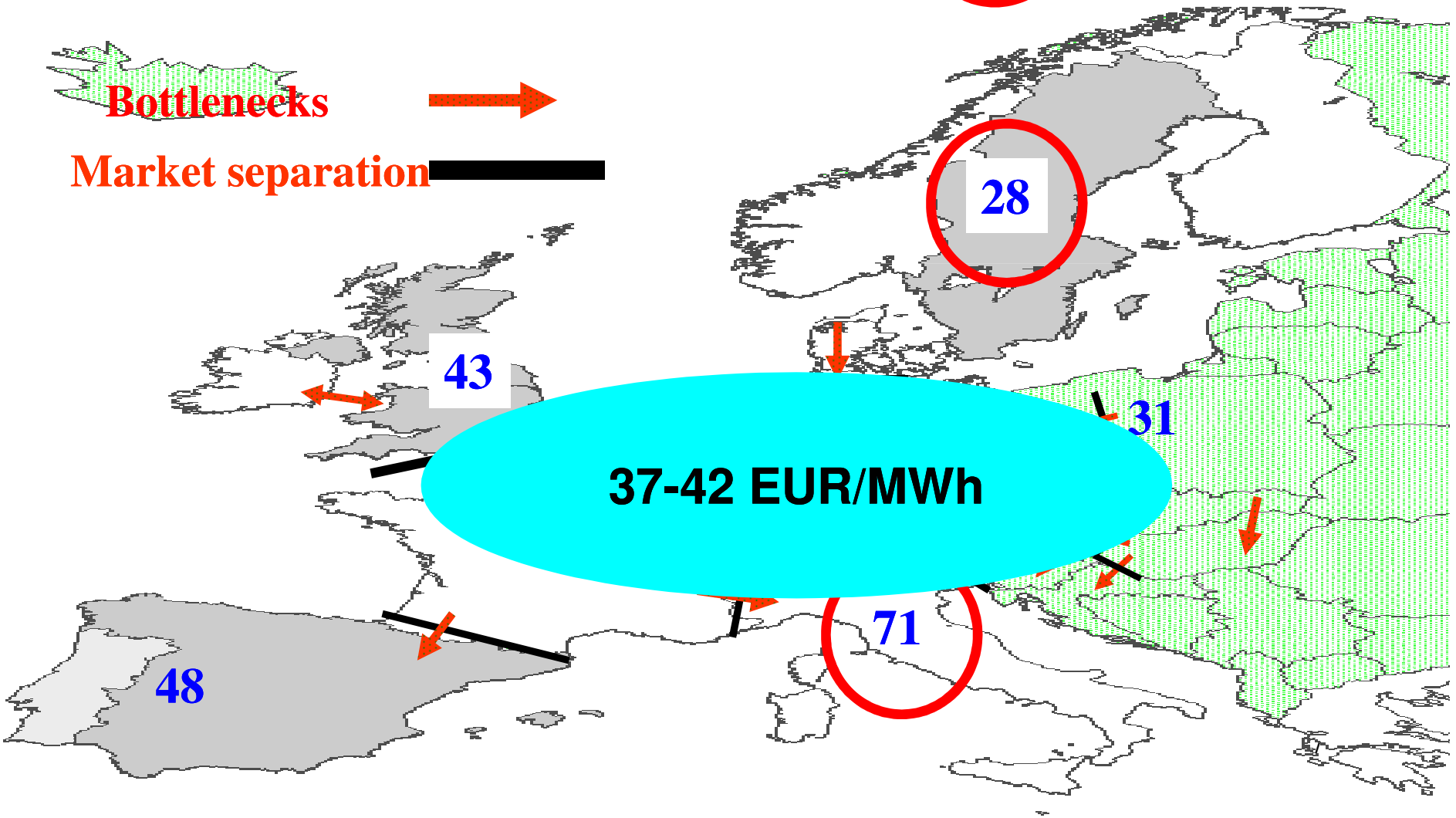
2. Liberalised vs regulated electricity markets

- **Major objective of liberalisation of ESI in Europe: lead to ONE European electricity market**
- **Core motivation:**

  LIB → Competition! → lower prices!

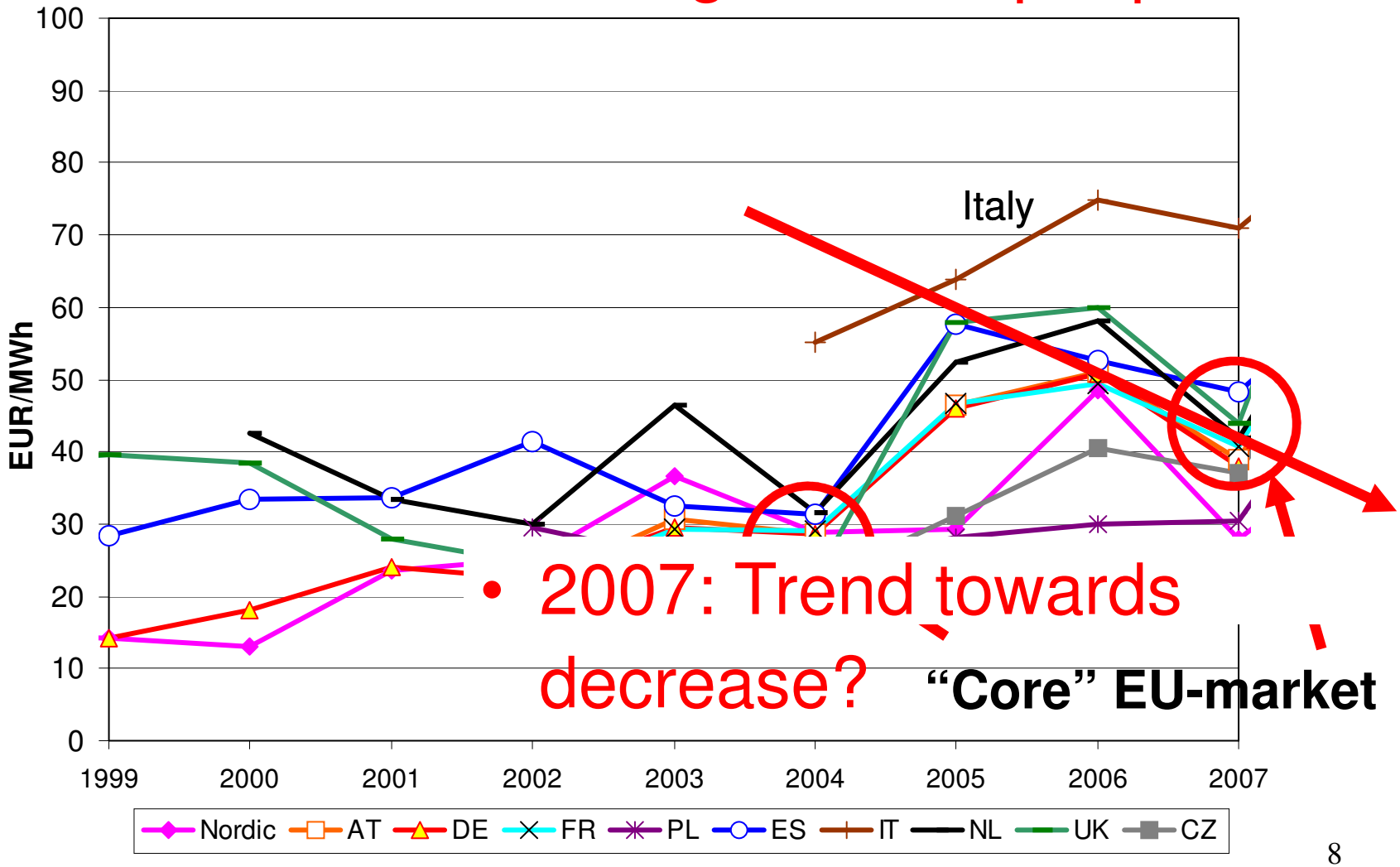
1. INTRODUCTION

Average wholesale electricity price 2007 [€/MWh]



1. INTRODUCTION

- 2007: Slow convergence of spot prices?

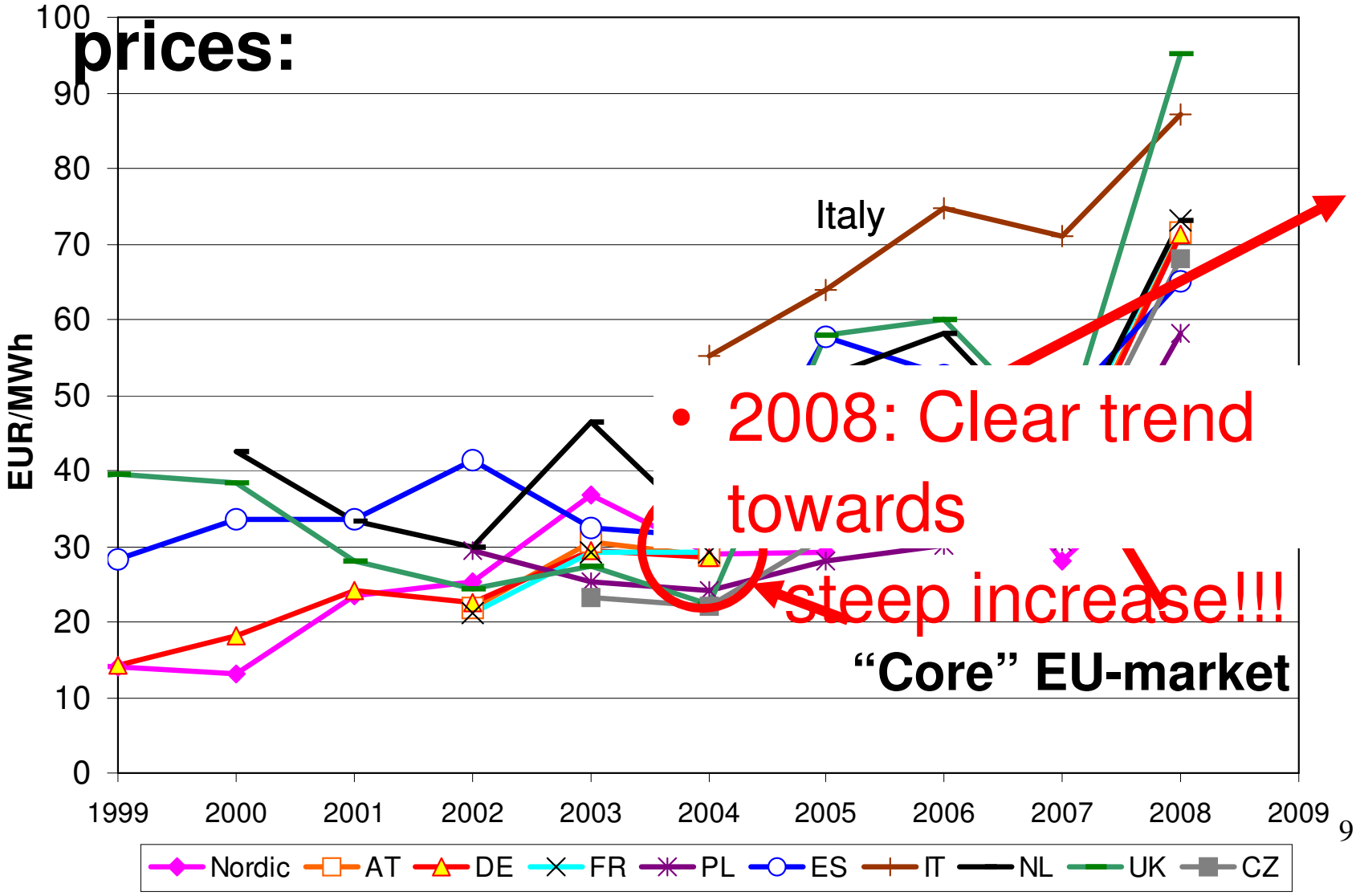


- 2007: Trend towards decrease?

"Core" EU-market

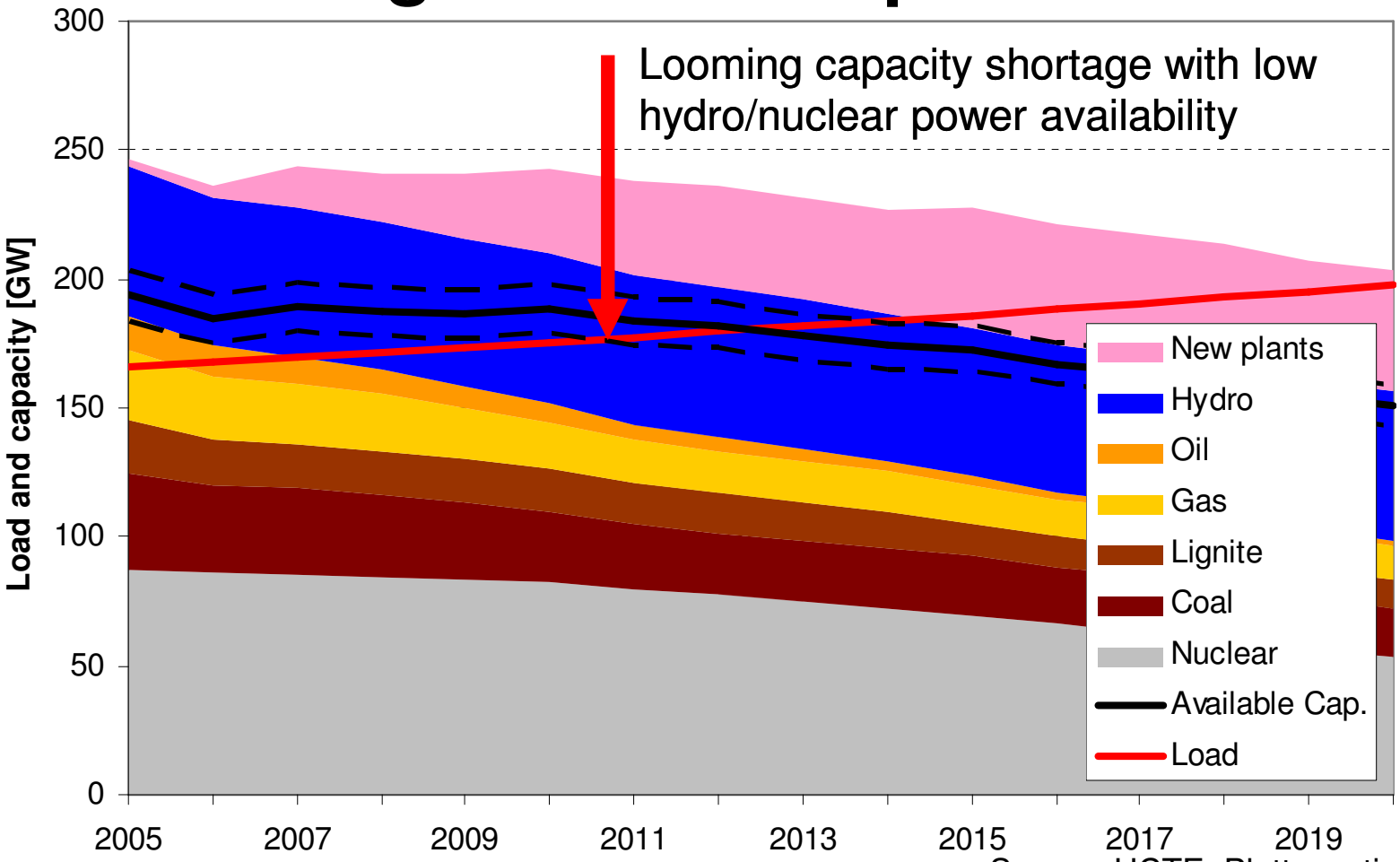
1. INTRODUCTION

- **At some times convergence of spot prices:**



2. THE "EU-4" MARKET

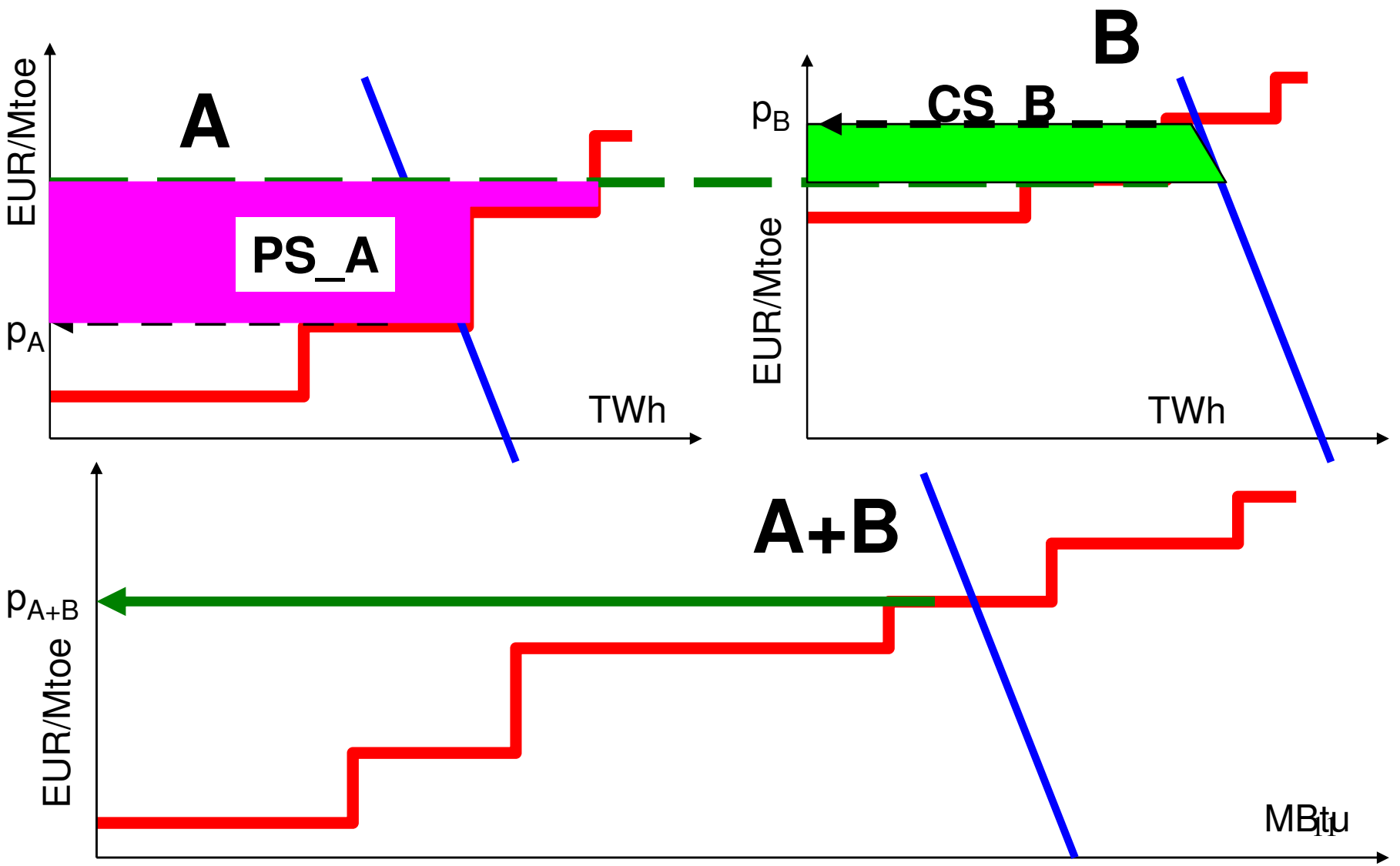
- **Trends in generation capacities and load:**



Source: UCTE, Platts, national statistics

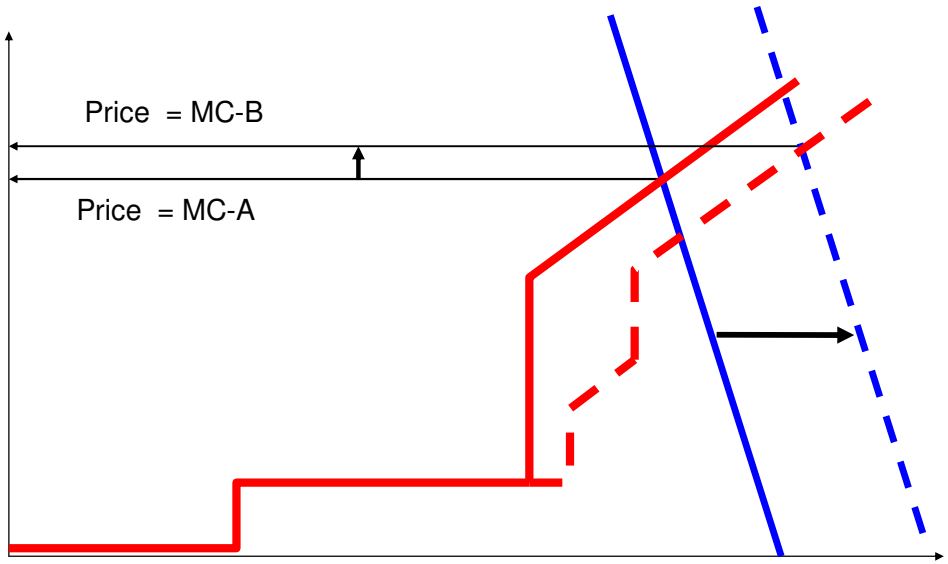
- **Variations and uncertainties in available capacities play a**

3. MARKET INTEGRATION

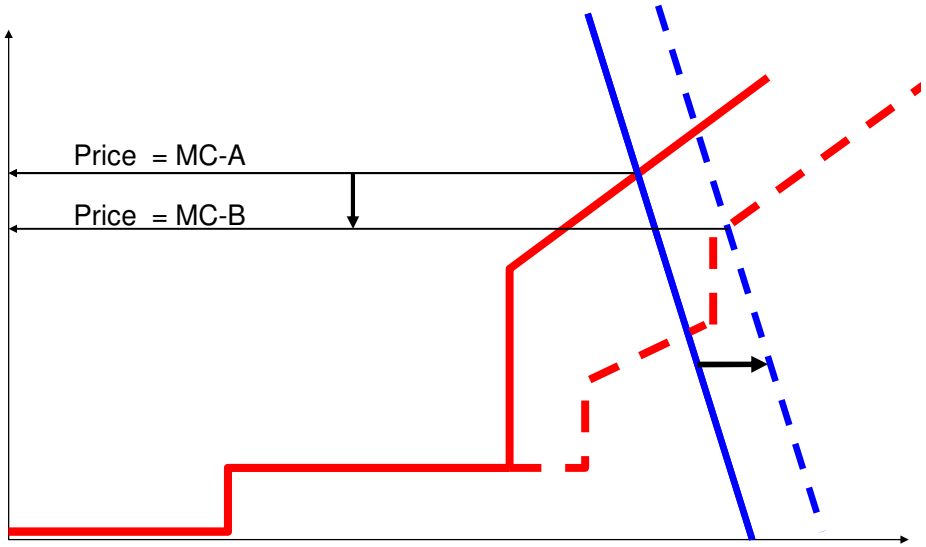


3. MARKET INTEGRATION

- **Comparison of price effects:**



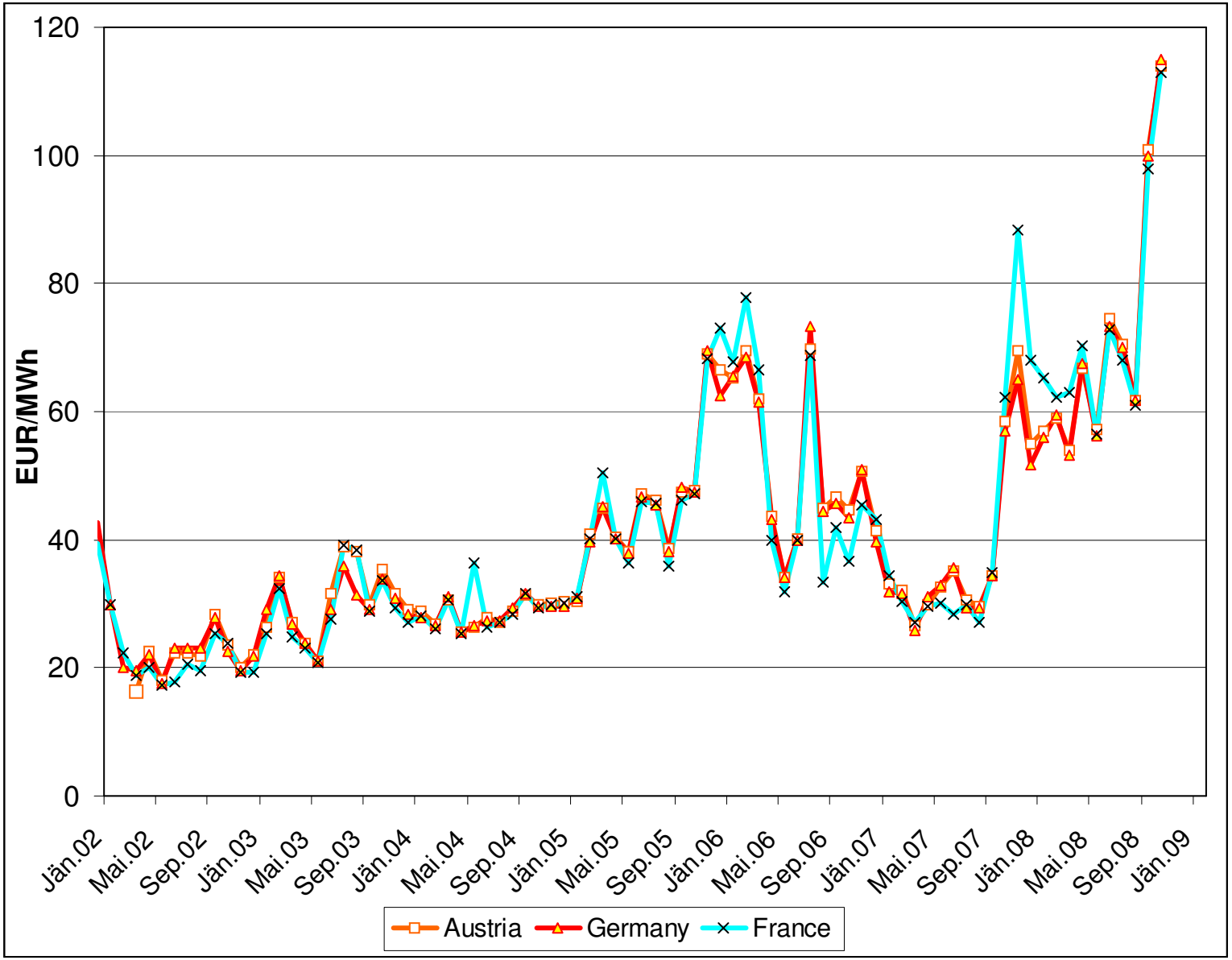
Adding a “short” country



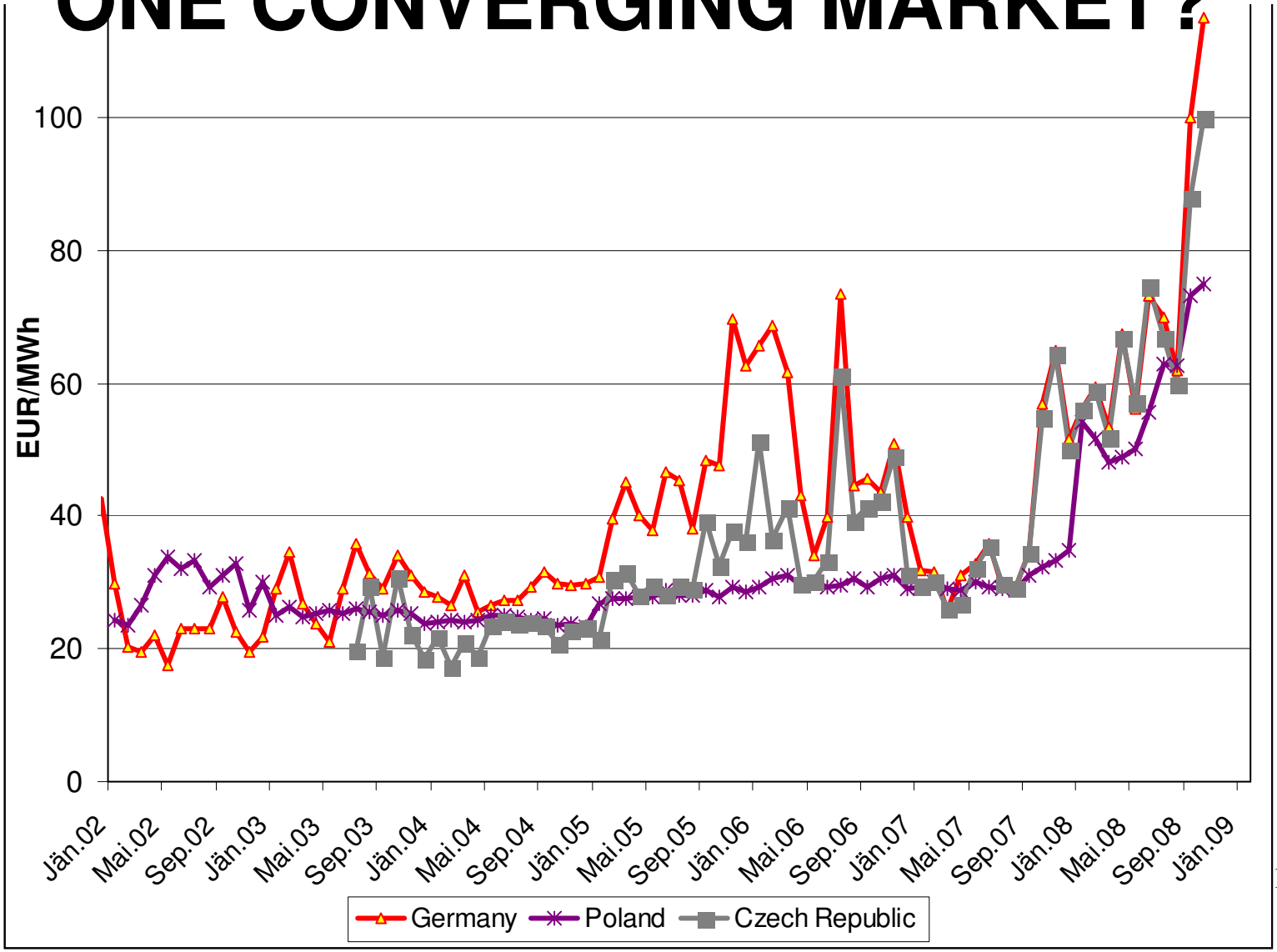
Adding a “long” country

- **Are “new” countries really long?**

FRANCE, GERMANY, AUSTRIA – ONE MARKET

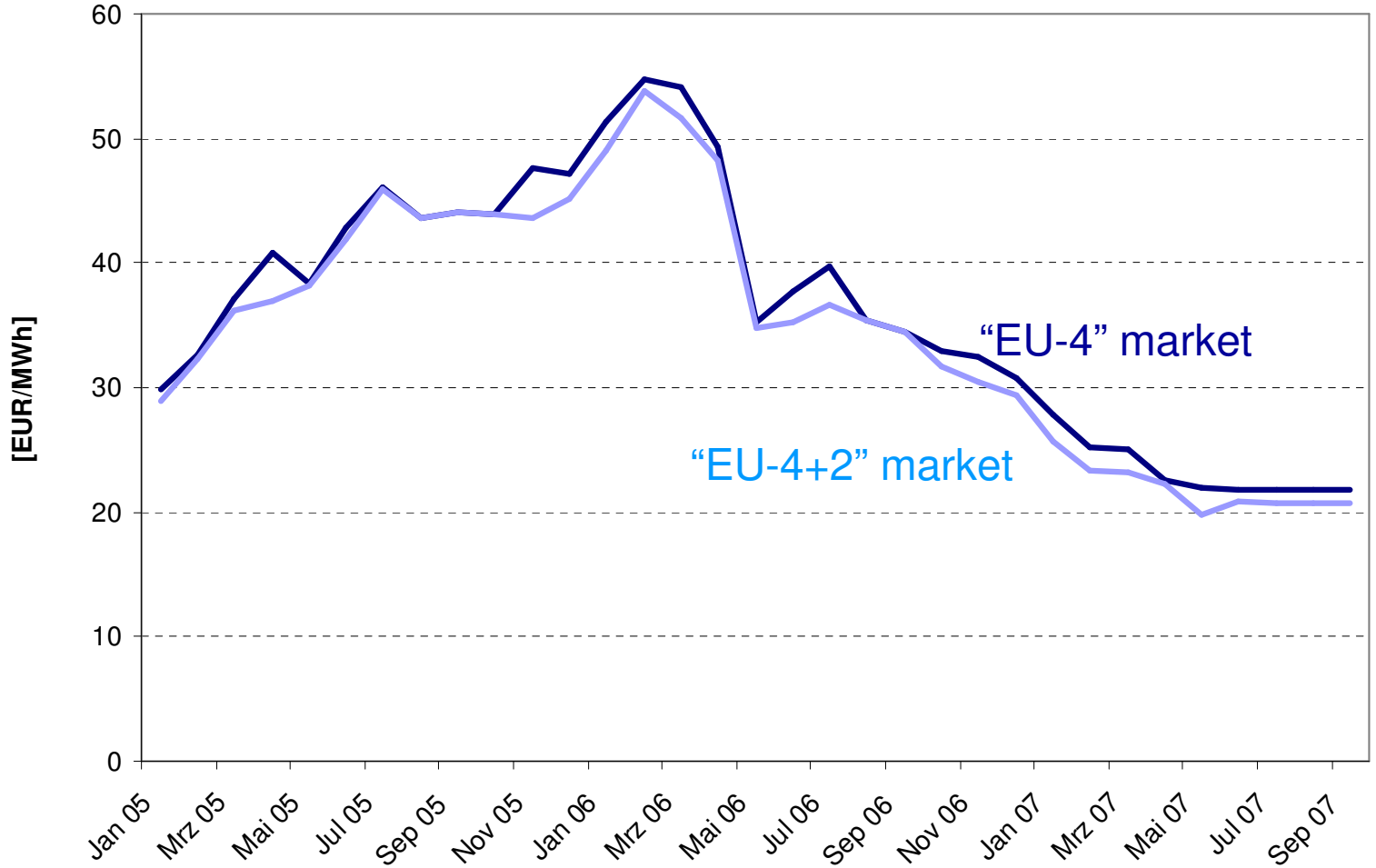


FRANCE, GERMANY, AUSTRIA, CZECH REPUBLIC, POLAND – ONE CONVERGING MARKET?



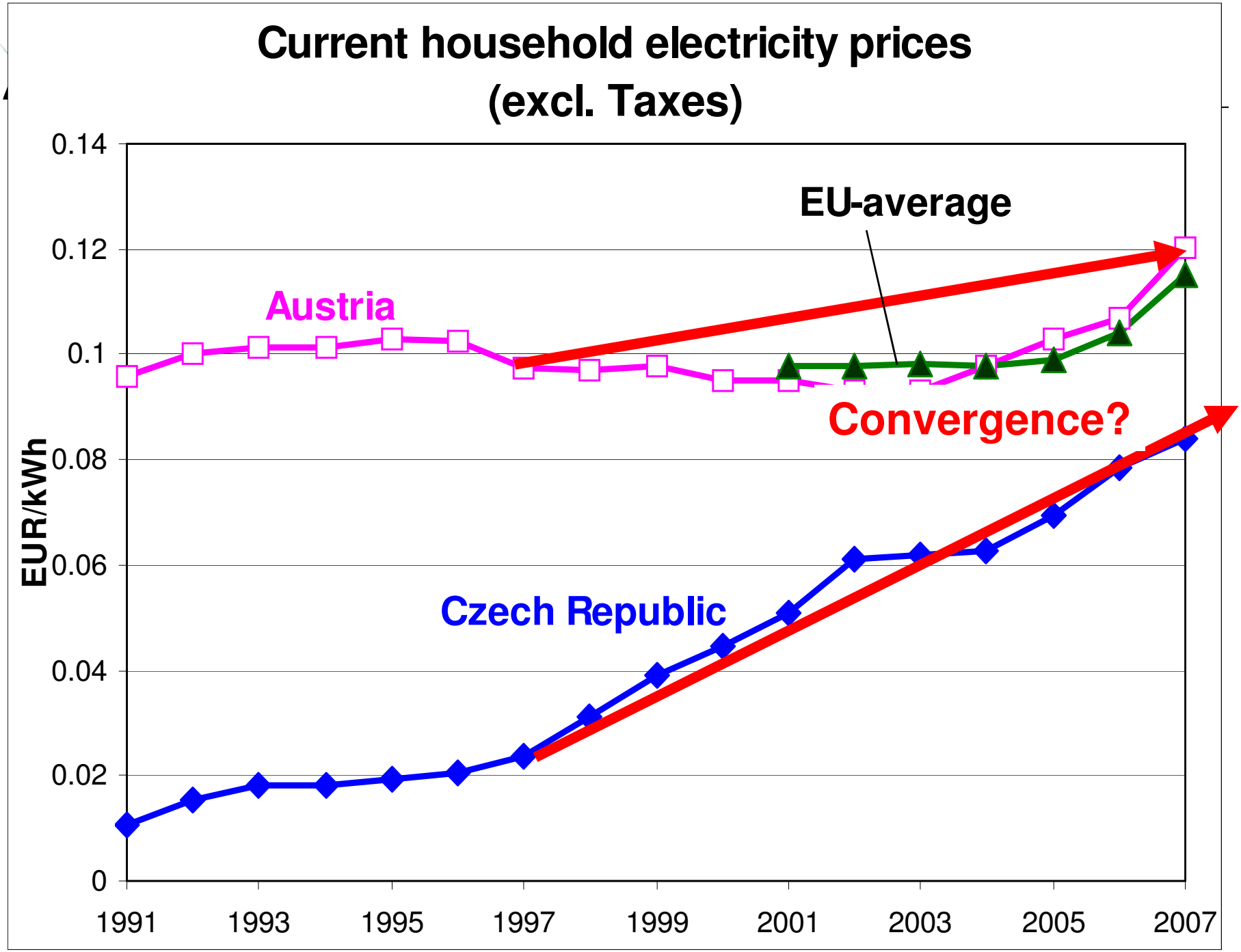
3. MARKET INTEGRATION

- **Hypothetic price effects by integrating**



Source: EEX, UCTE, BAFA, TU Vienna

- **Price reduction of 4% in the considered period – How**


Current household electricity prices
(excl. Taxes)
EUR/kWh
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1991
1993
1995
1997
1999
2001
2003
2005
2007
EU-average
Austria
Convergence?
Czech Republic

3. PROMOTING RENEWABLES FOR ELECTRICITY AND HEAT

PROMOTING RENEWABLES FOR ELECTRICITY GENERATION

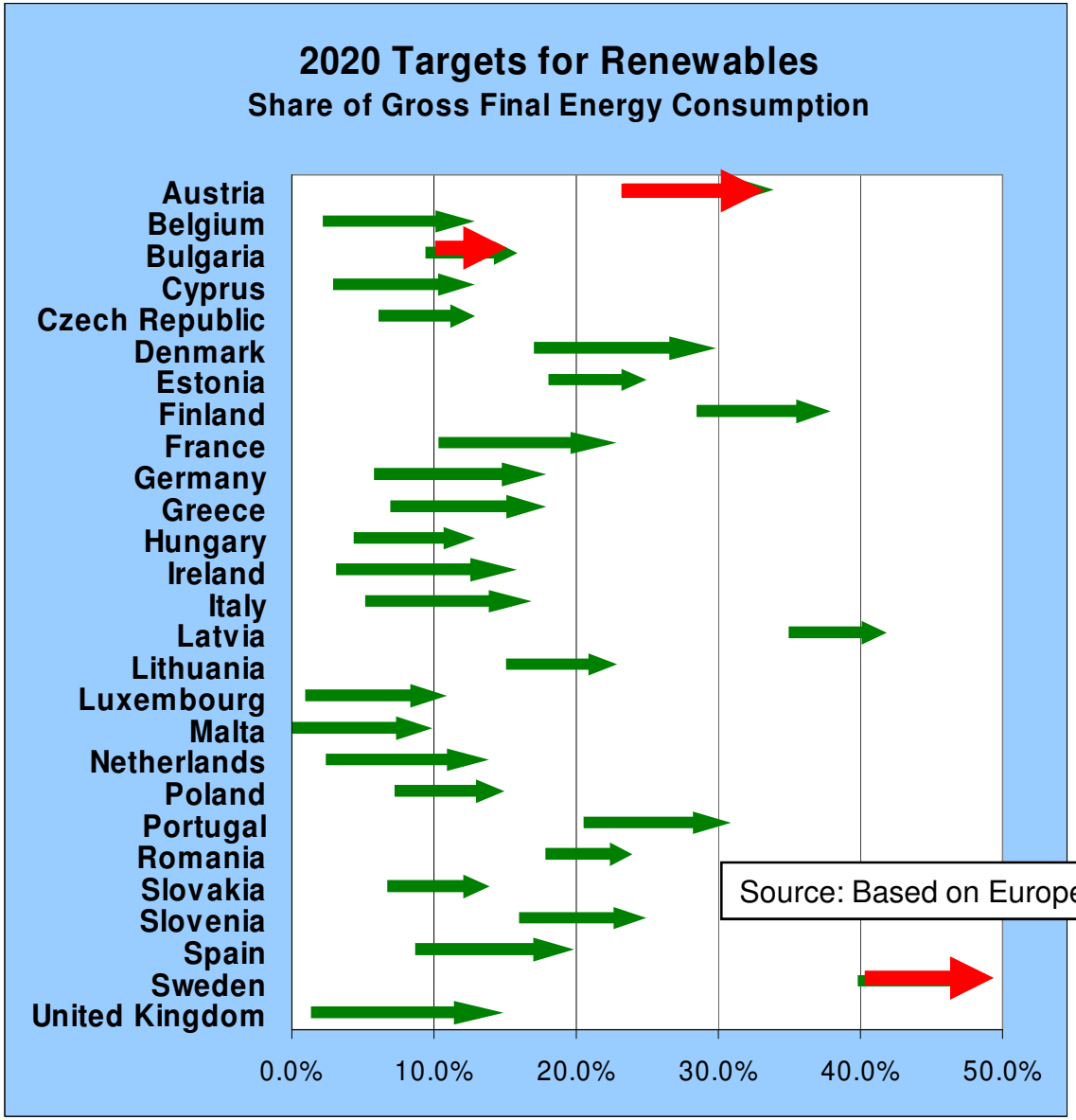
CORE MOTIVATION:

Policy targets for an INCREASE of RES-E!

e.g. 20/20/2020 targets

RES-E directive: increase share of RES-E from 12% 1997 to 22% in 2010)

EU RES targets for 2020:



Source: Based on European Commission (COM(2008) 19)

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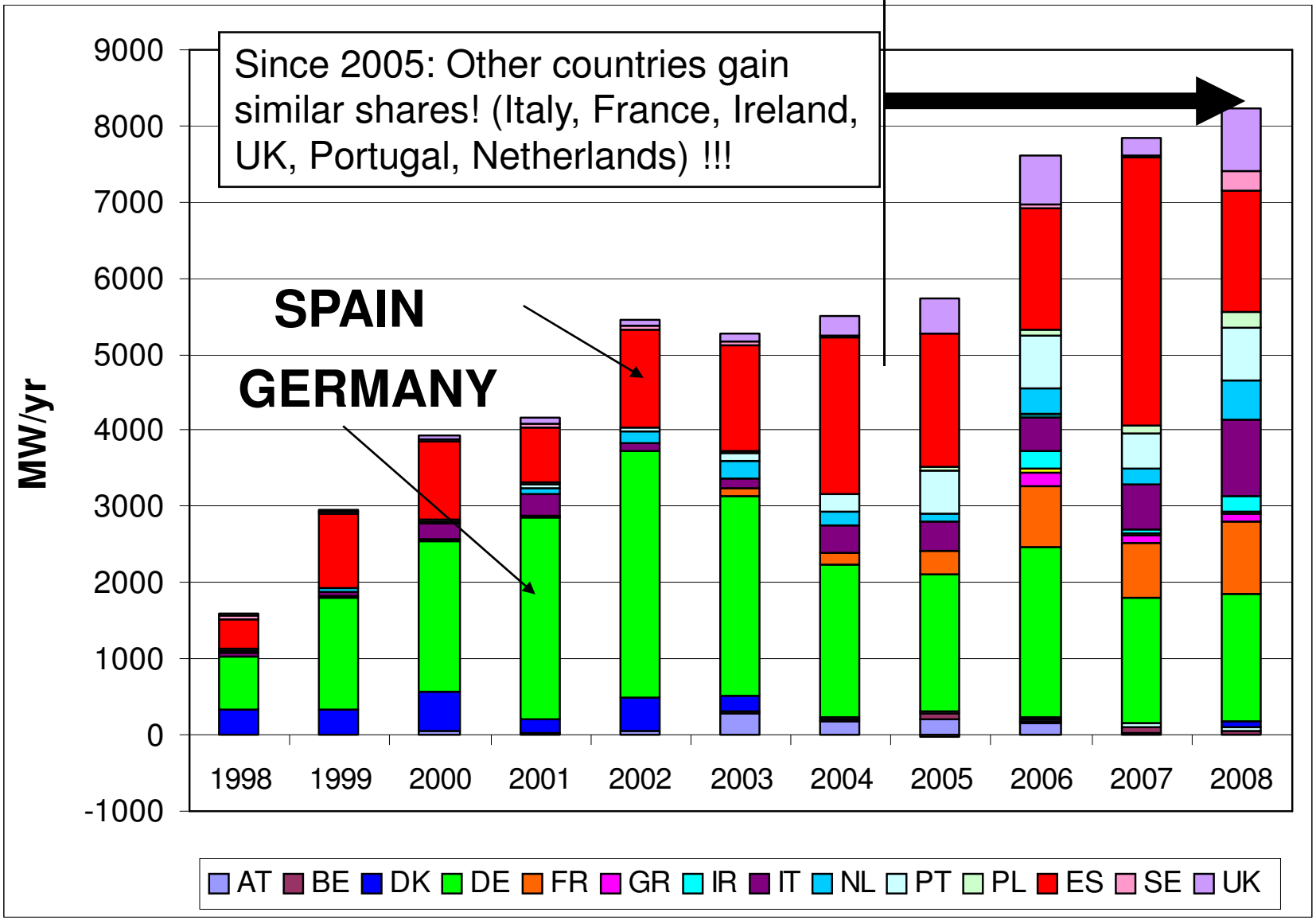
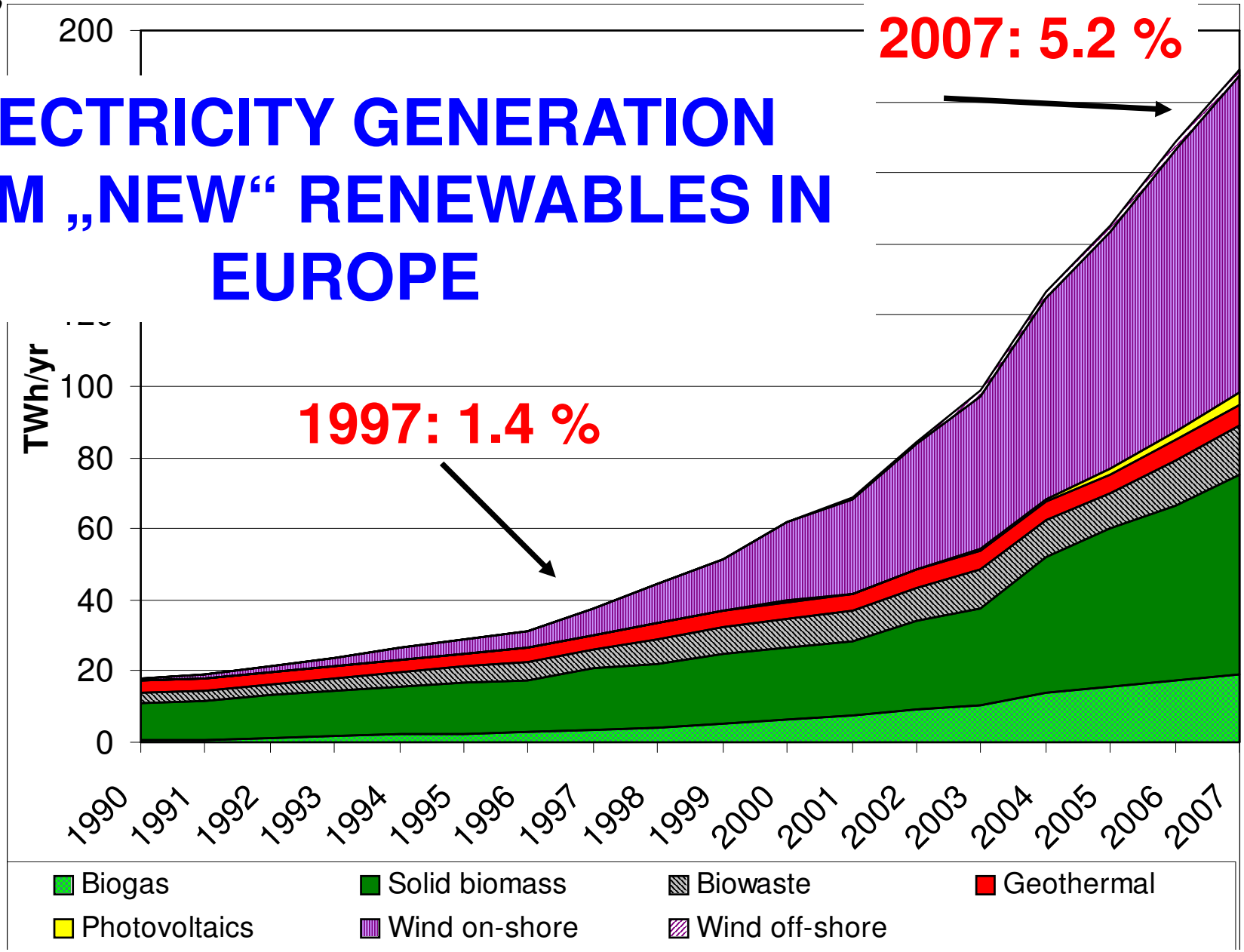
REMARK ON RES – DEPLOYMENT IN THE EU-COUNTRIES

- **Since about 1997 triggered by EU-directives and EU initiatives**
- **Yet, specific country success stories very strongly related to national policies design!**
- **Moreover, current harmonisation efforts not necessarily towards most effective and efficient policies!**

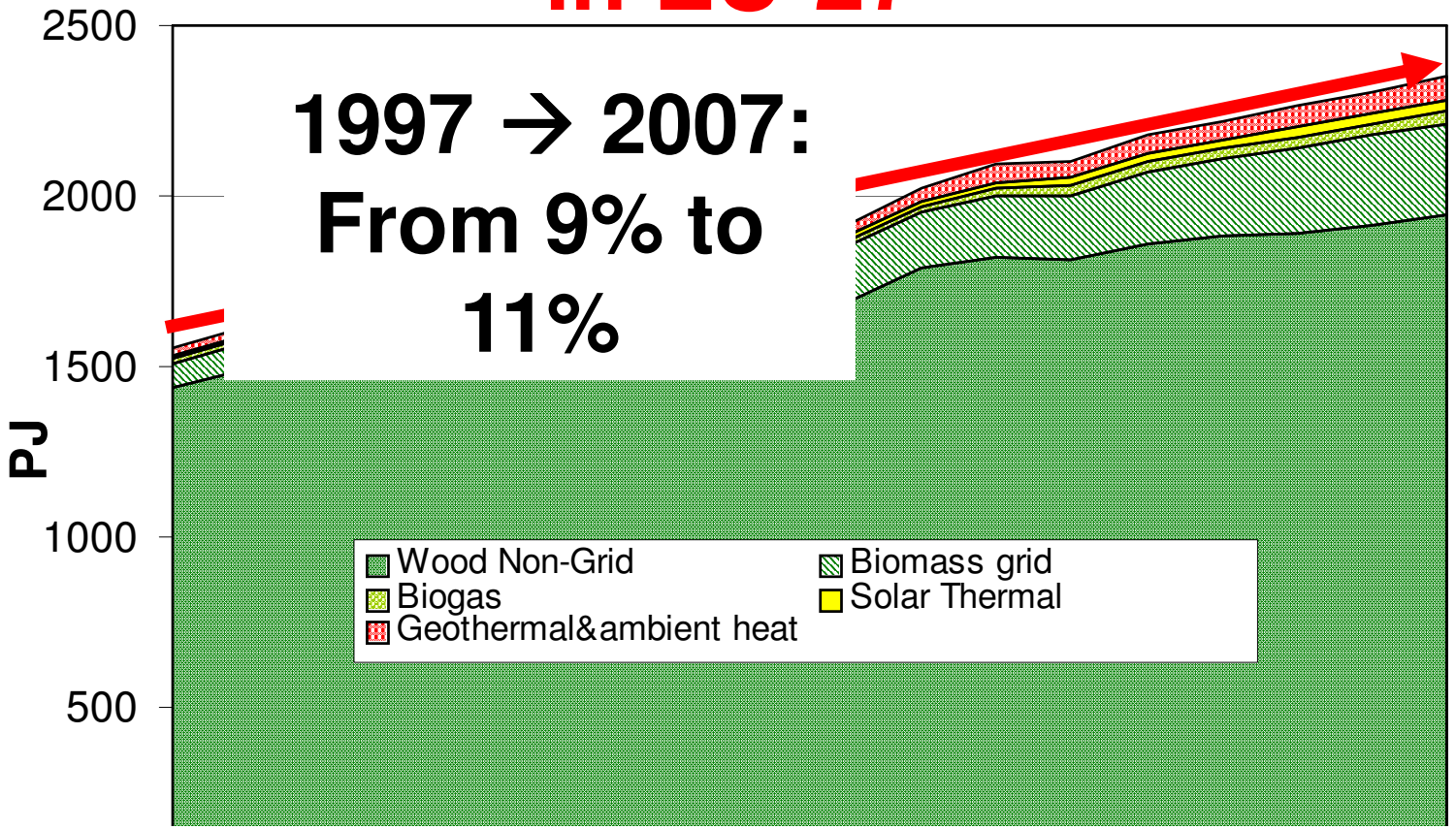
Wind in EU-27: Installed capacities per year



ELECTRICITY GENERATION FROM „NEW“ RENEWABLES IN EUROPE



Heat from renewables in EU-27



Main support instruments: Subsidies and income tax incentives for biomass boilers and solar thermal collectors

SURVEY ON STRATEGIES FOR PROMOTING RENEWABLE ENERGY

		REGULATORY	VOLUNTARY
Capacity-driven strategies	Generation-based	GO-Trade	• National generation targets
	Investment focused	• Bidding/Tendering	• National installation or capacity targets
Price-driven strategies	Generation-based	• feed-in tariffs, • [illegible] based incentives • Net metering	• Green Power Marketing • Green tariffs • Solar stock exchange
	Investment focused	• Rebates • Soft loans • Tax incentives	• Contracting • Shareholder progr. • Contribution • Bidding
Other		–	• NGO-marketing • Selling green buildings • Retailer progr. • Financing • Public building prog.

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MAJOR PROBLEM:

Correct design of policy

- with respect to:
- which targets to be reached when?
- Financial incentives
- Credibility for investors
- costs for customers

THE ISSUE OF TRANSFER COSTS

All regulatory promotion schemes (Quota-based TGC systems, tendering systems, Feed-in tariffs) create an

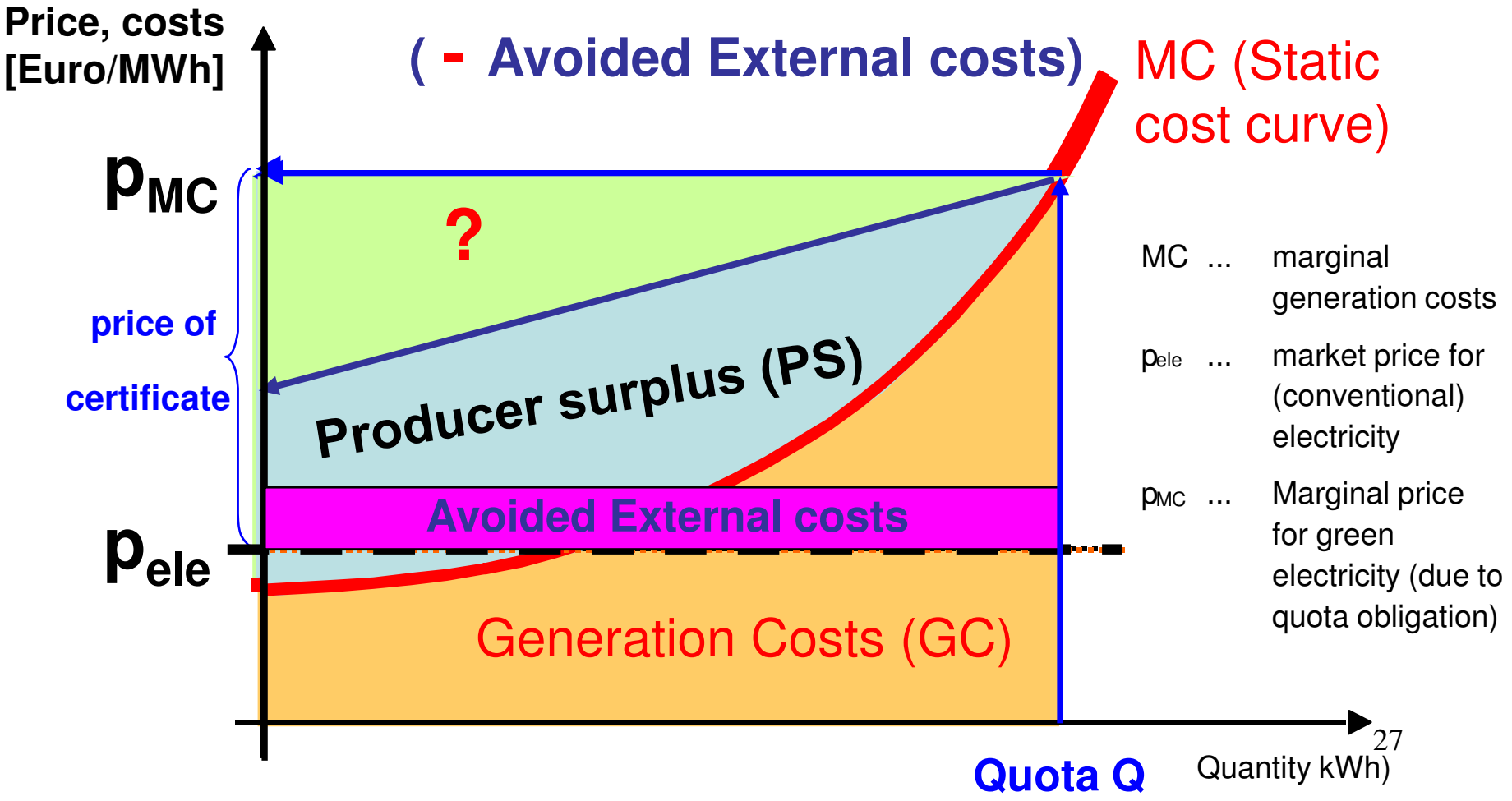
artificial market

and cause

transfer costs (additional costs)

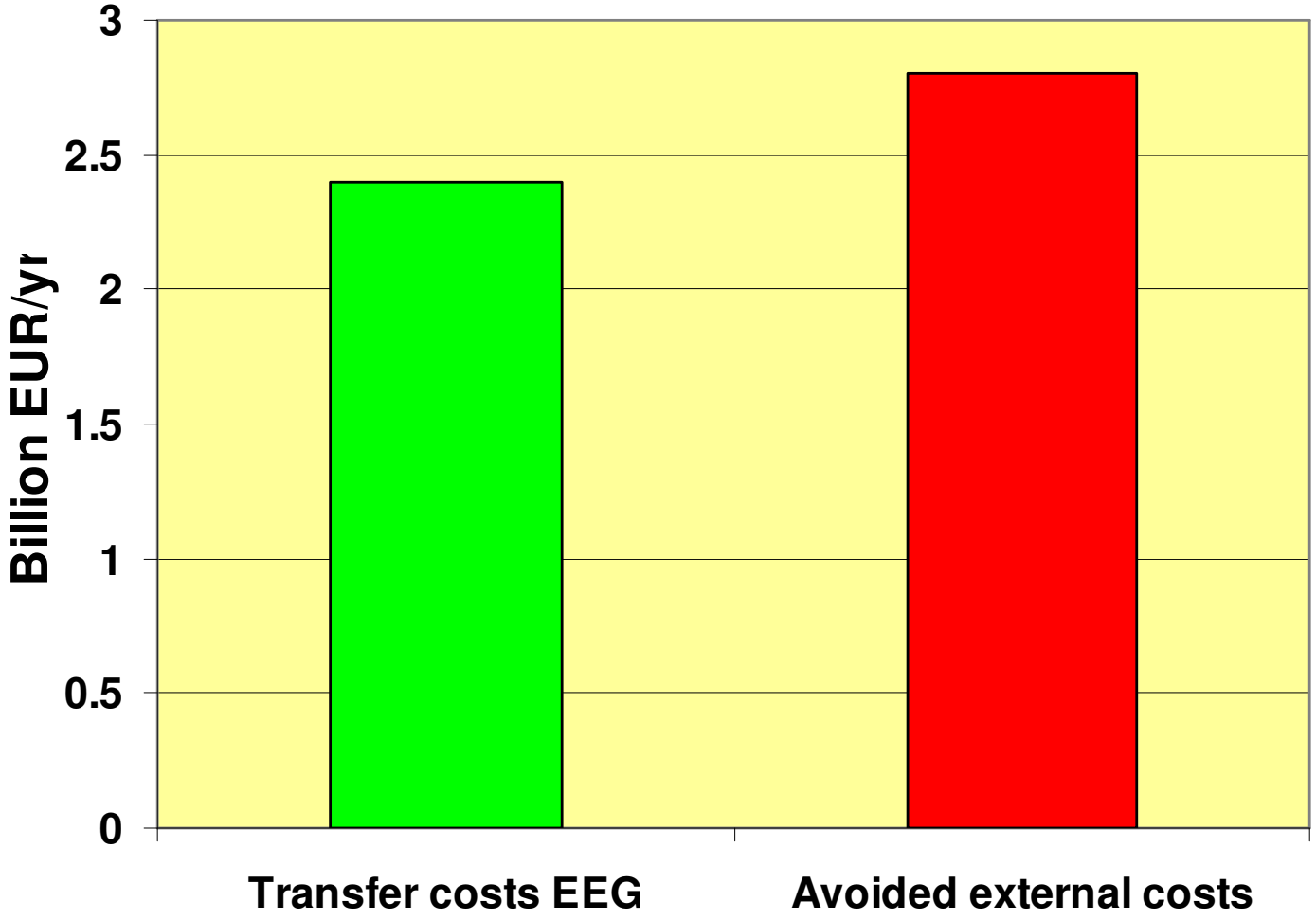
How to minimise transfer costs

Minimise additional costs for consumers = Producer Surplus + Generation costs - Revenues electricity market



Transfer costs vs avoided costs

Example: Promotion of wind in Germany 2005



Source: Krewitt/Schlomann: Externe Kosten …(2006)

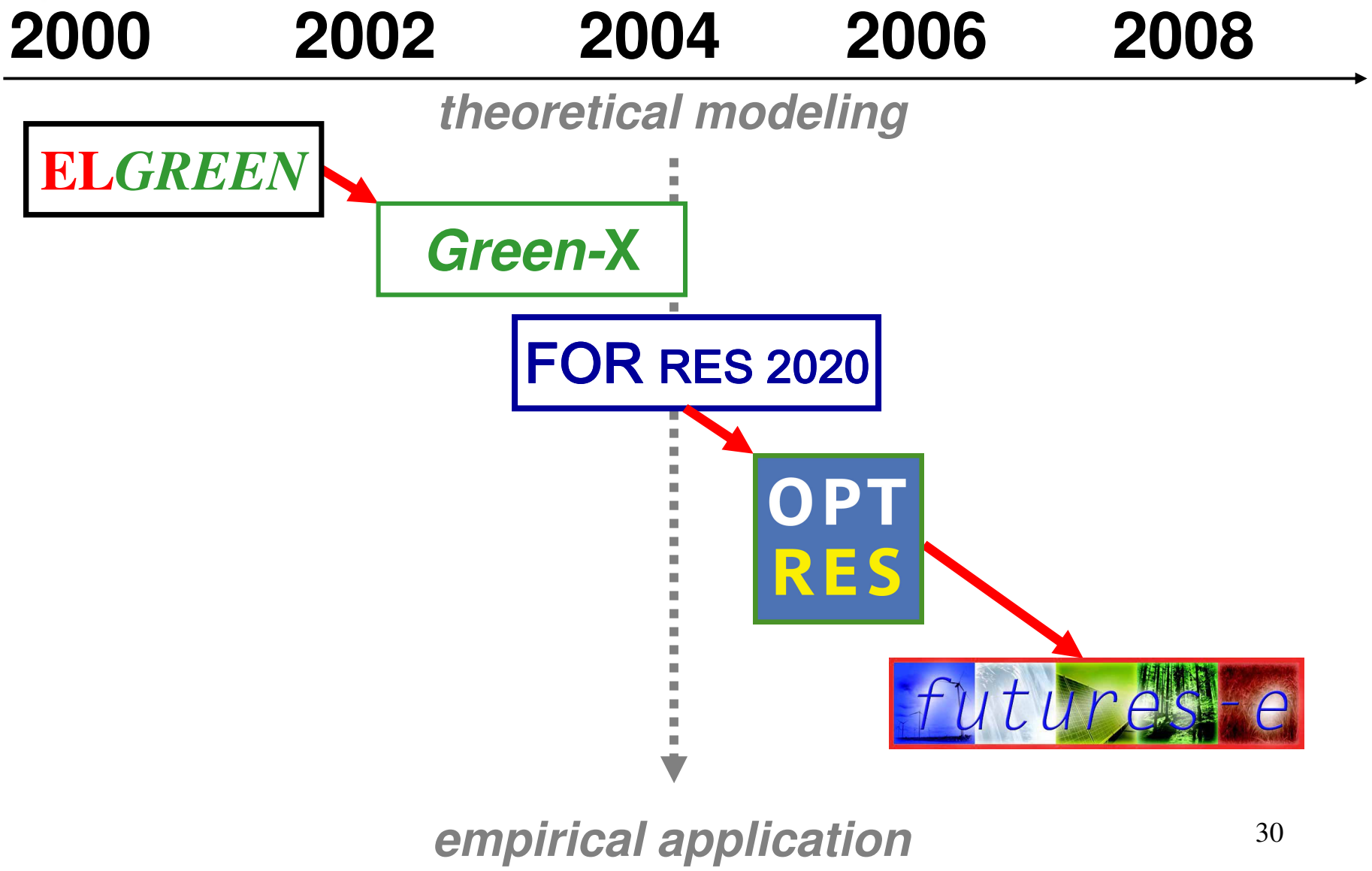
The lower the additional costs (=transfer costs) are which have finally to be paid by electricity customers

the higher will be public acceptance

the larger will be the amount of additional electricity generated from RES.

>>The "policy" track <<

Evolution



>>The track on "RES-E grid integration" <<

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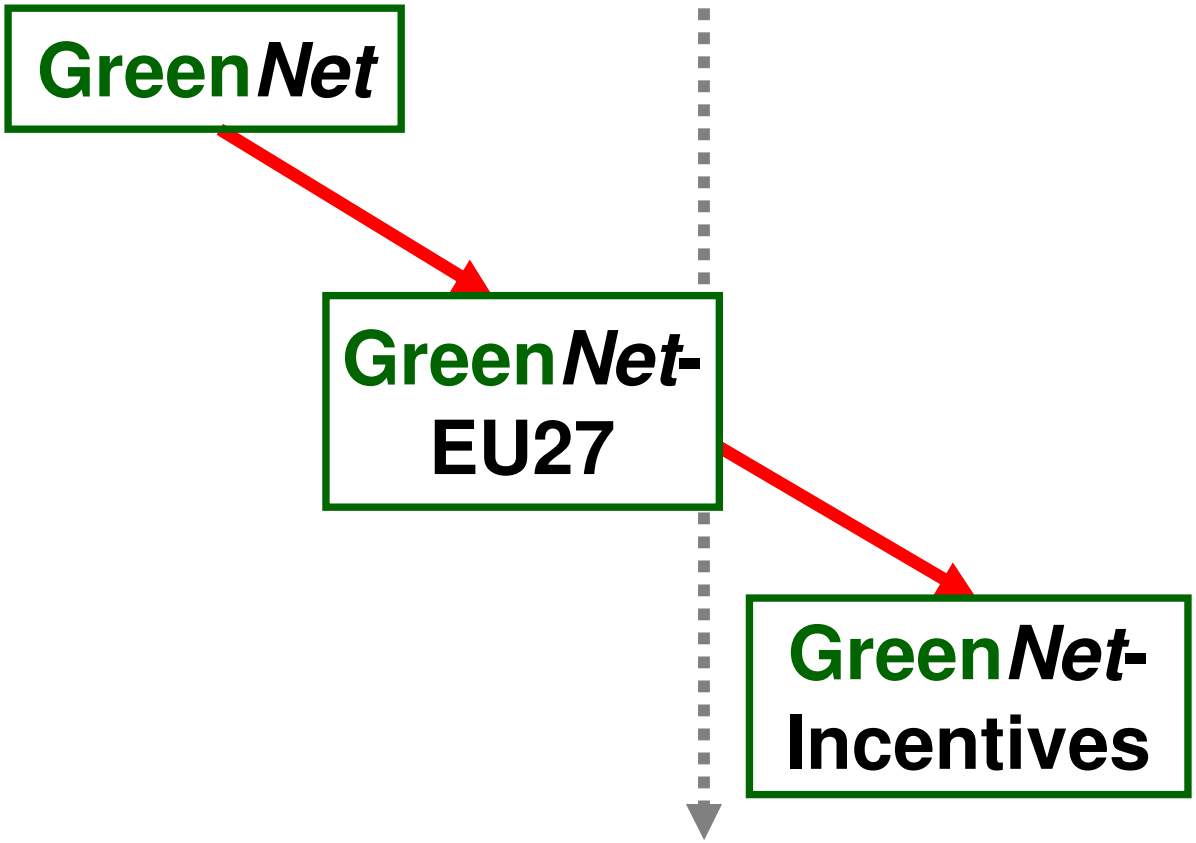
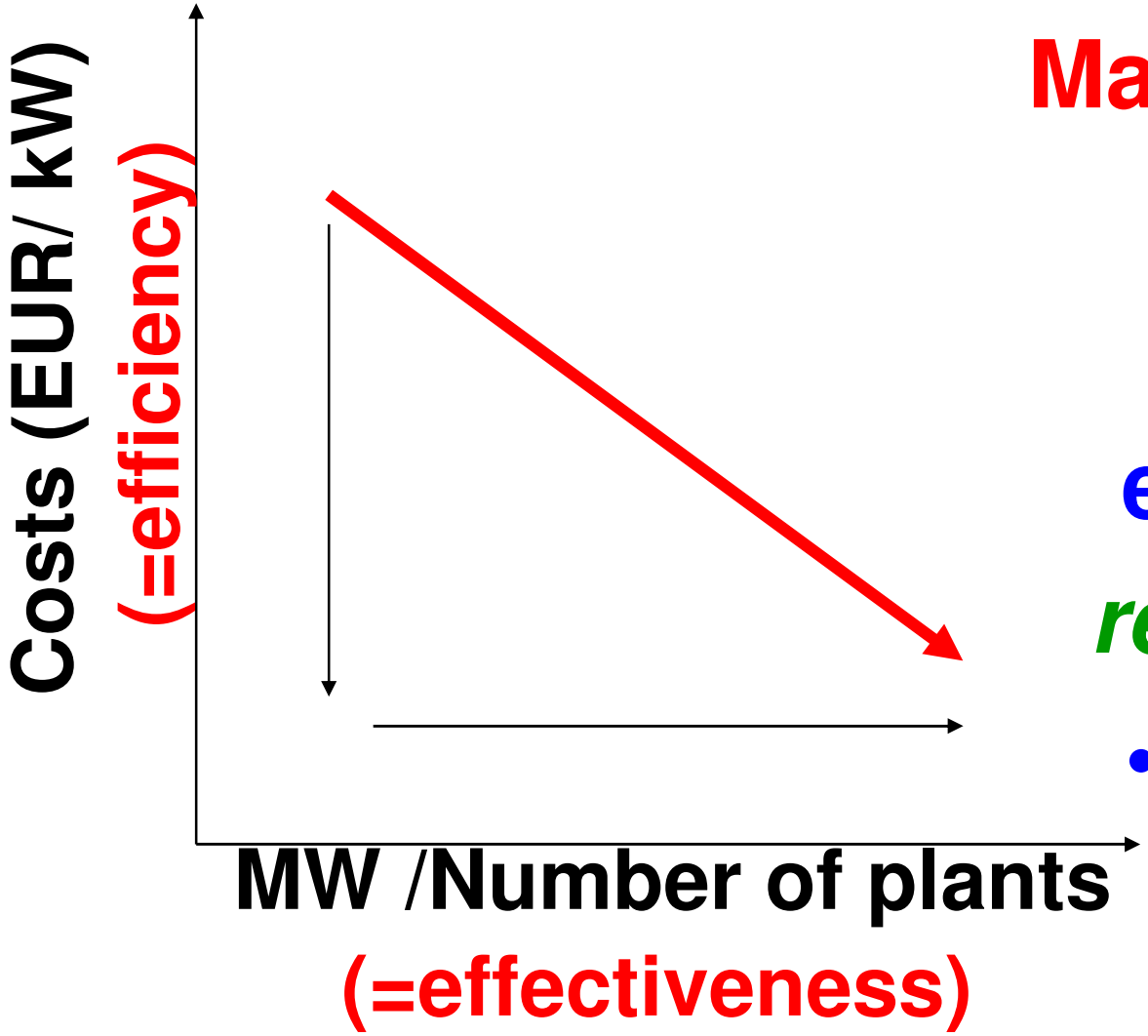
2002 2004 2006 2008 2010

theoretical modeling



empirical application

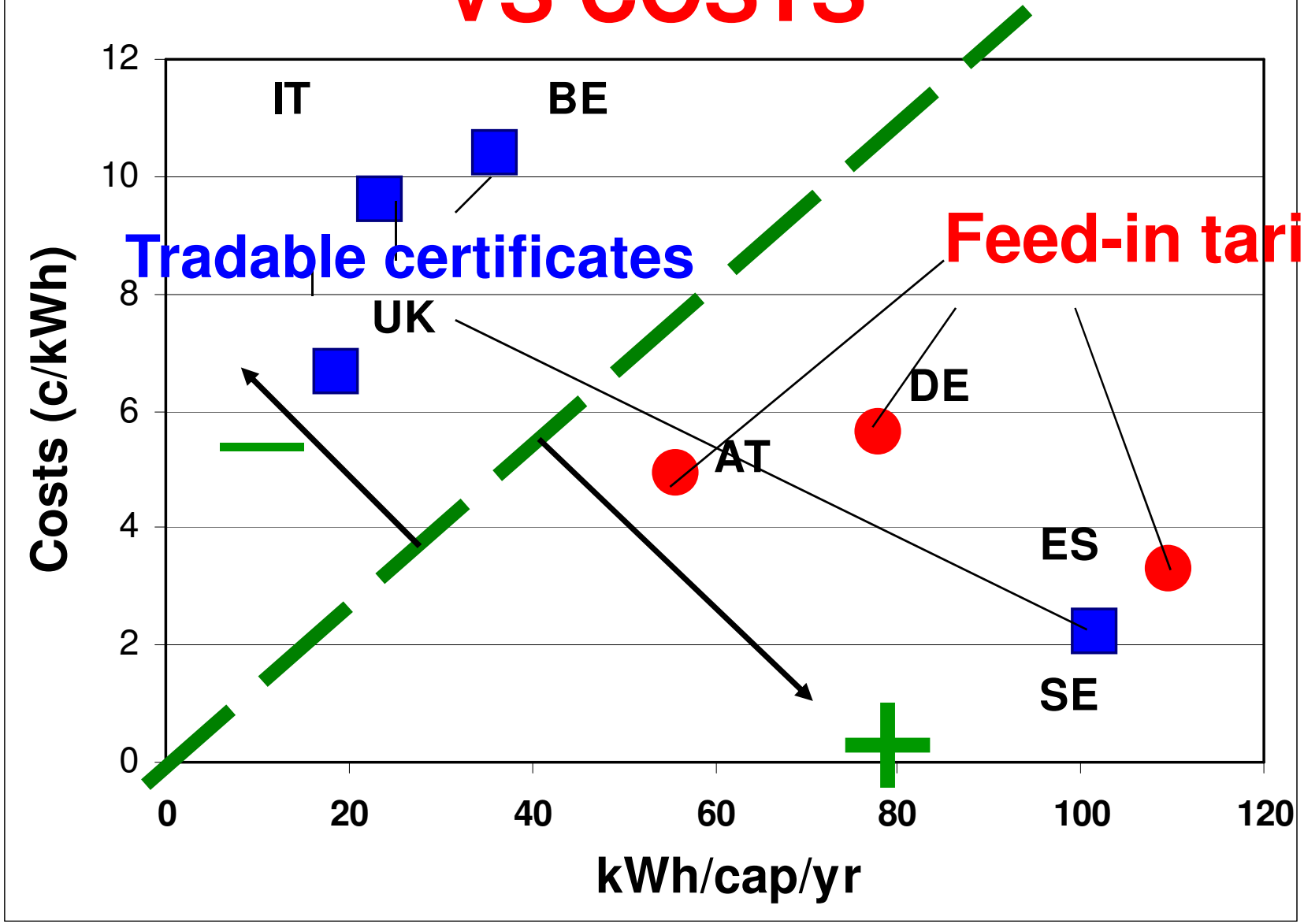
SUCCESS OF STRATEGIES



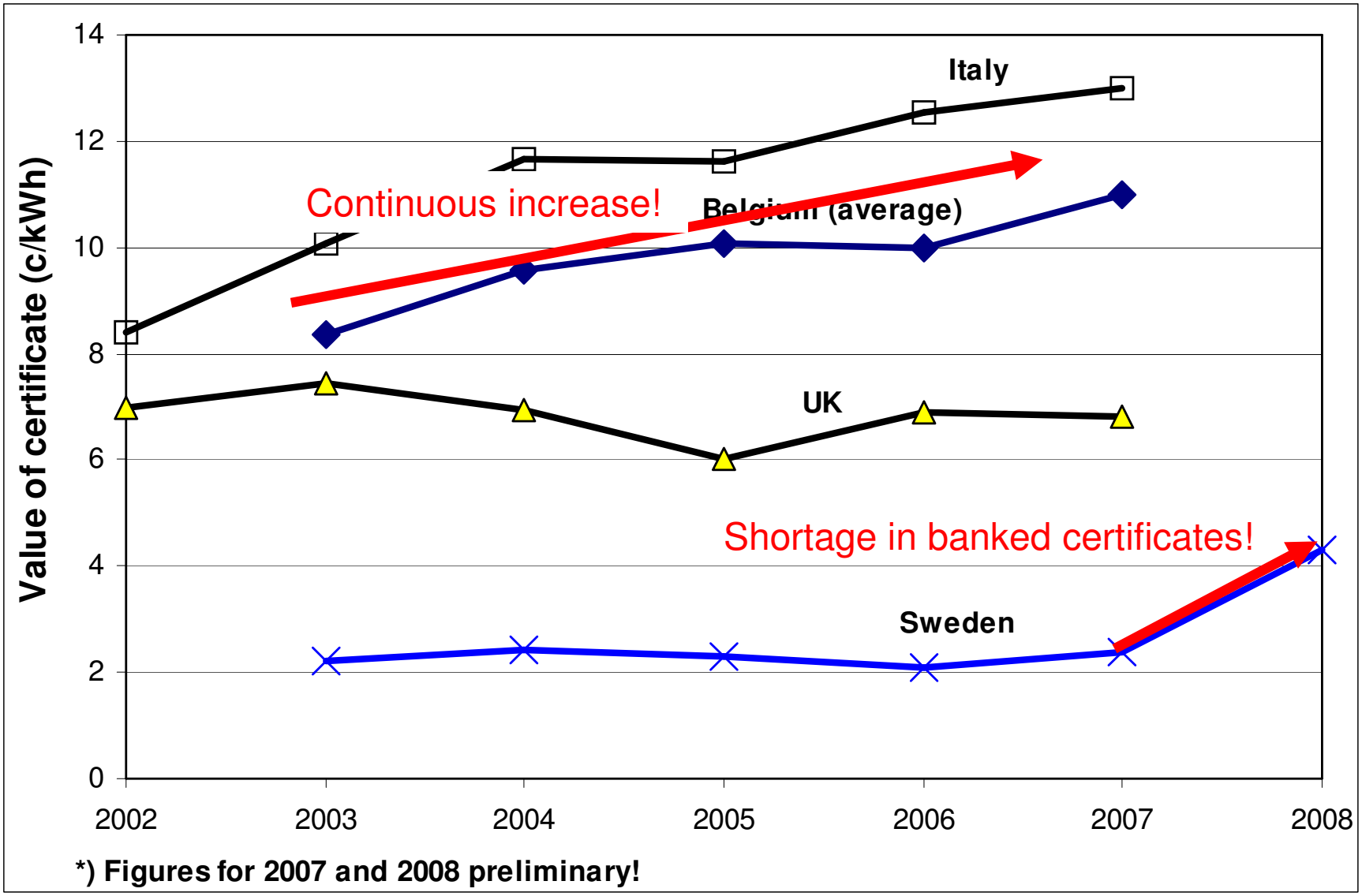
Major objectives:

- **increase the amount of electricity from *renewables* and**
- **reduce costs!**

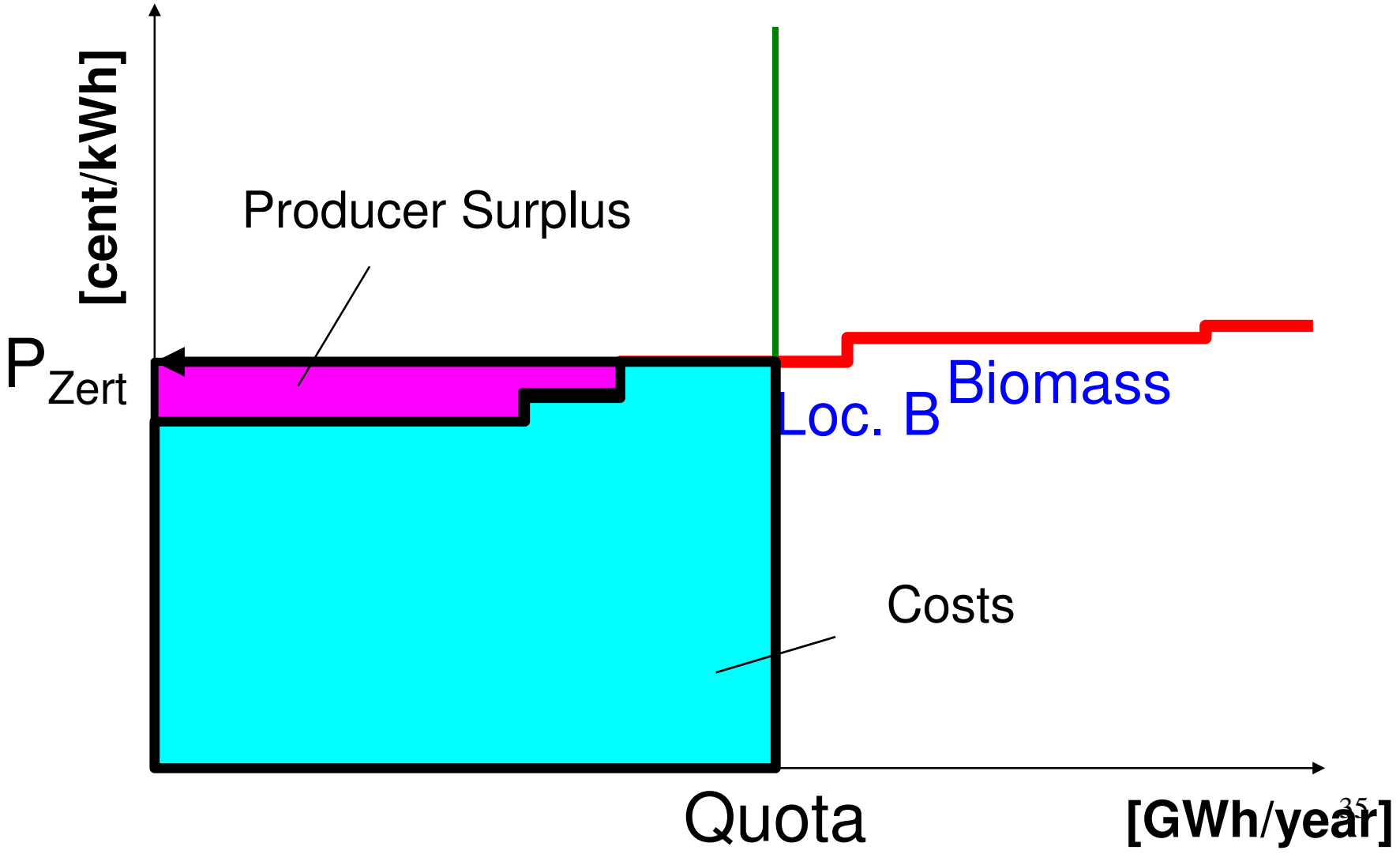
EFFECTIVENESS VS COSTS



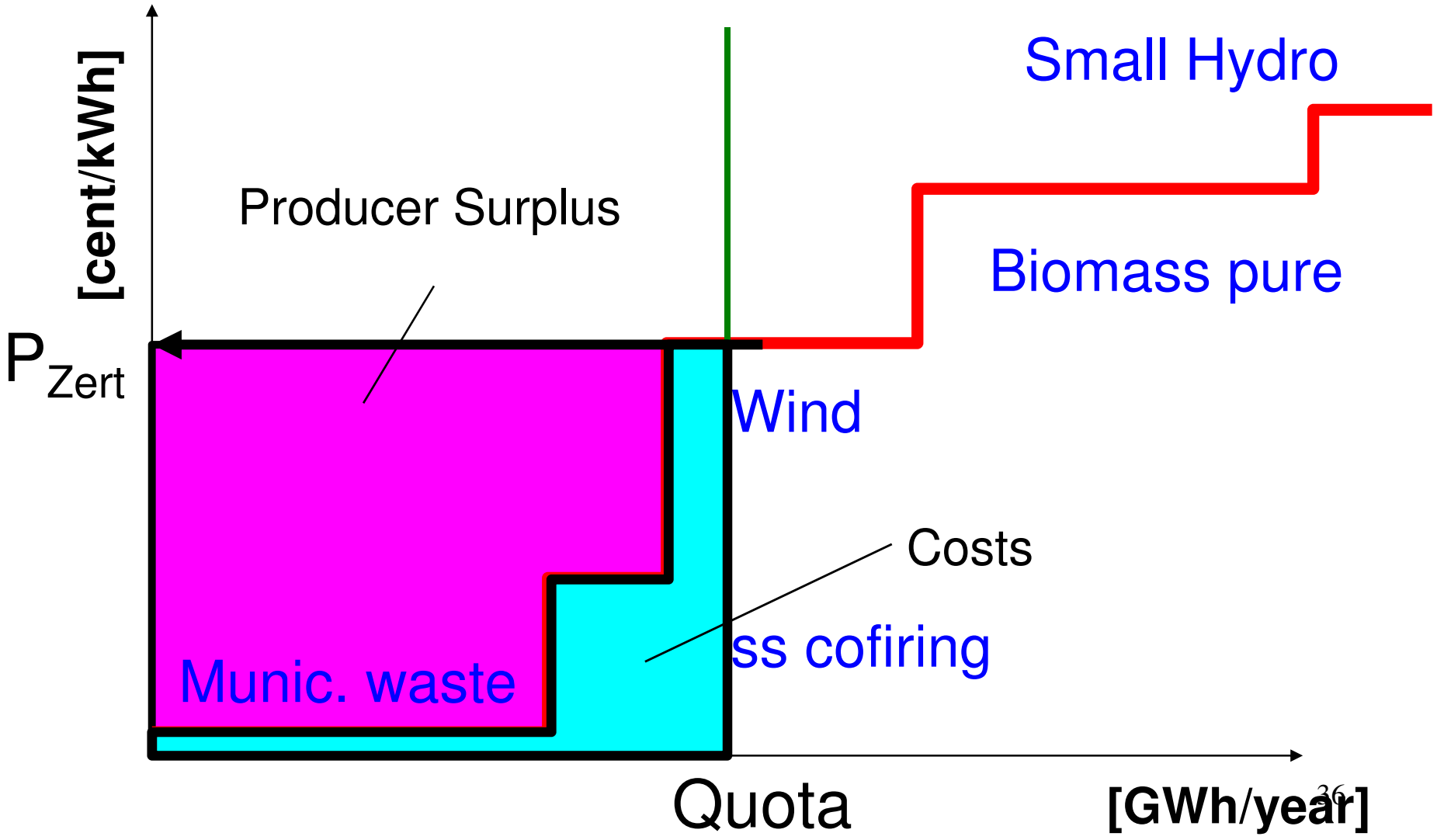
PRICES OF CERTIFICATES



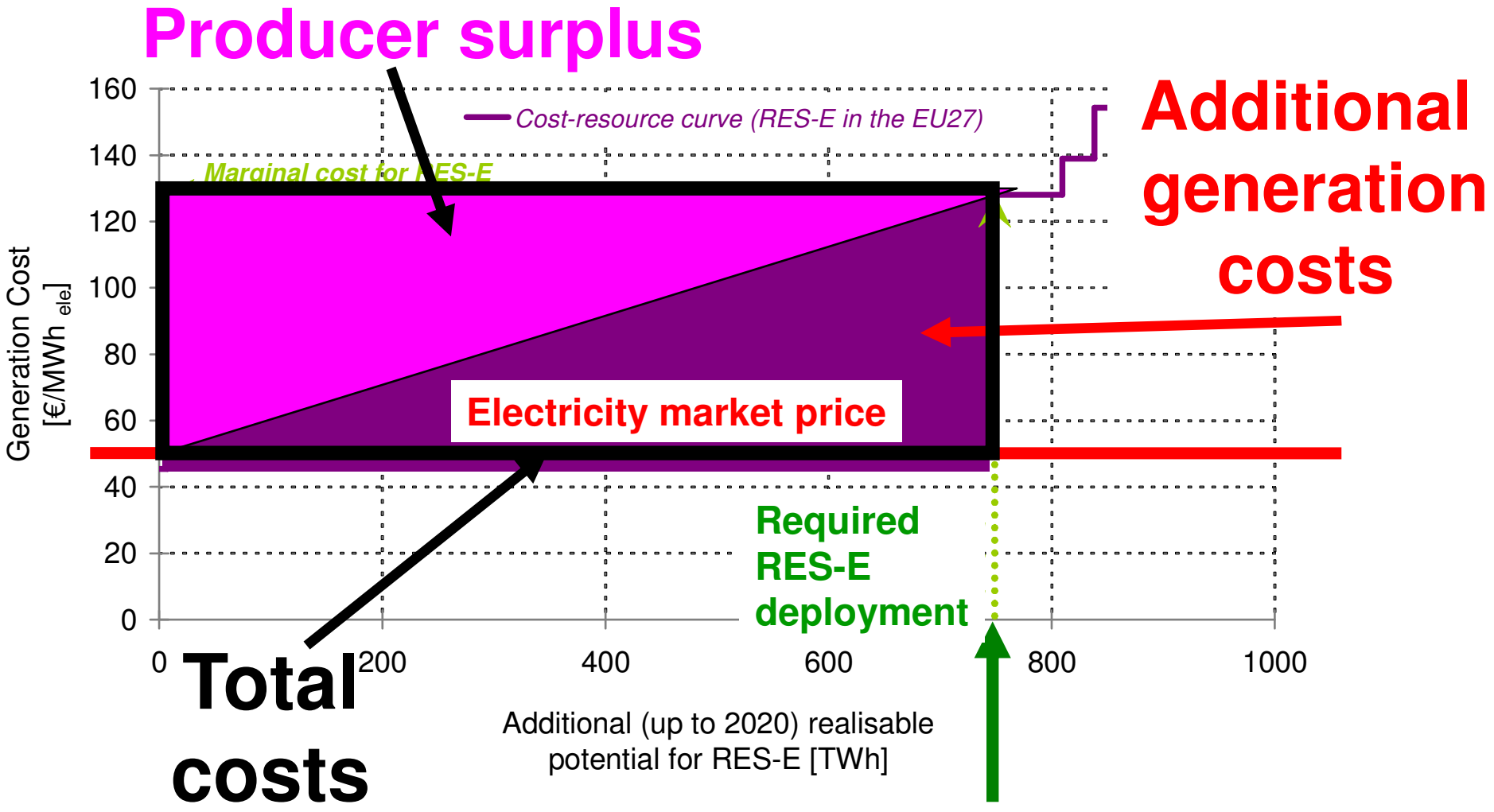
IMPACT OF THE SHAPE OF THE COST CURVE



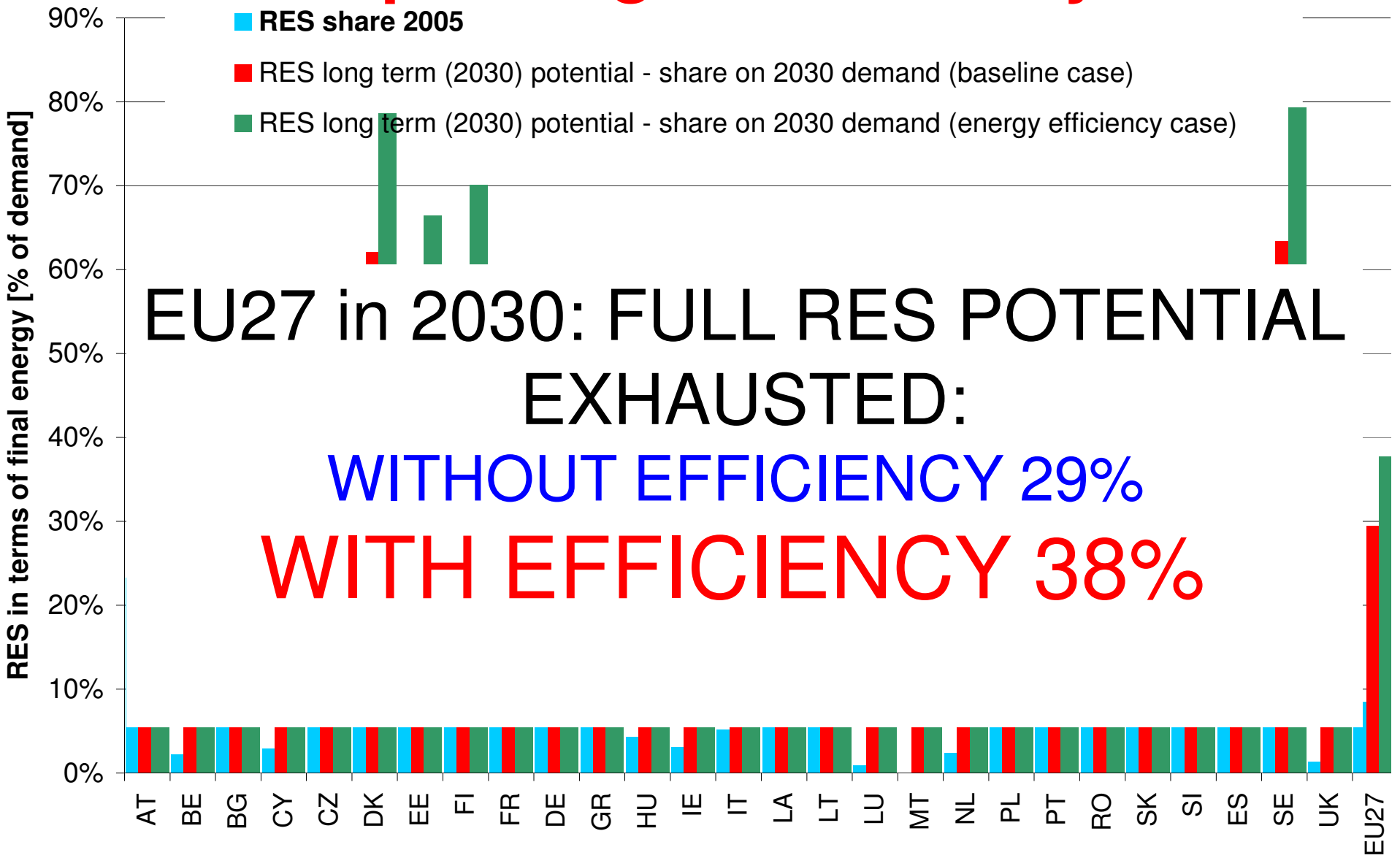
IMPACT OF THE SHAPE OF THE COST CURVE



THE SHAPE OF THE COST CURVE E U - 27



EU27: Potential share of RES depending on efficiency



EU27 in 2030: FULL RES POTENTIAL EXHAUSTED:

WITHOUT EFFICIENCY 29%

WITH EFFICIENCY 38%

CONCLUSIONS (1)

Careful design of a strategies:

IMPROVE/OPTIMIZE THE CURRENT SYSTEMS BEFORE HARMONISING OR IMPLEMENTING MAJOR CHANGES!

deployment fastest and at lowest costs for society. We expect GO Trade to be a very expensive way to promotes RES

CONCLUSIONS (2)

- Instead of harmonisation: Stimulate/Foster competition between promotion schemes/between countries: Which system/where provides new RES-E capacities at lowest costs for society?
- Exchange of lessons learned: Improvement of strategy design must build on lessons learned
- Promoting RES in EU successful? Yes, but increase in energy consumption outweighed …
- For sustainable policy -> parallel focus on demand-side conservation of high priority!
- Supporting RES? Yes, but … externality-based taxation of all energy carriers preferable!

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  www . eeg . tuwien . ac . at
  www . green-x . at
  www . optres . fhg . de

- **E-Mail to:**
  Reinhard.Haas @ tuwien. ac.at

Deriving effective least-cost policy strategies for alternative automotive concepts and alternative fuels

(ALTER-MOTIVE)

www.alter-motive.org

Amela Ajanovic, Reinhard Haas

Intelligent Energy Europe

ALTER-MOTIVE

ALTER-MOTIVE

- **Coordinator:**
- EEG, Vienna university of Technology

- **Partners:**
  - Stichting Energieonderzoek Centrum Nederland, The Netherlands
  - Eni Corporate University S.P.A., Italy
  - BSR Sustainability GmbH, Germany
  - Wuppertal Institut für Klima, Umwelt, Energie GmbH, Germany
  - AEOLIKI Ltd, Cyprus
  - Black Sea Energy Center, Bulgaria
  - Association Rhônalpénergie-Environnement, France
  - Centre for Renewable Energy Sources, Greece
  - Stowarzyszenie The Kraków Institute for Sustainable Energy, Poland
  - Chalmers Tekniska Högskola Aktiebolag, Sweden
  - Forschungsgesellschaft Mobilität-Austrian Mobility Research, Austria
  - Sociedade Por Quotas CEEETA-ECO, Portugal
  - Det Økologisk Råd (EcoCouncil), Denmark

- **Duration:**
  1 October 2008 - 30 April 2011

Intelligent Energy Europe

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ALTER-MOTIVE

TU VIENNA — Technische Universität Wien / Vienna University of Technology

- The core objective is to derive effective least-cost policy strategies to achieve a significant increase in innovative alternative fuels (AF) and corresponding alternative more efficient automotive technologies (AAMT) to head towards a sustainable individual & public transport system.

- The heart of this project is an investigation of about 80 recently implemented successful case studies of pilot projects for marketing AF & AAMT from all over Europe and beyond.

- Furthermore, prospective scenarios on the future deployment of AF & AAMT will be developed, showing how to meet EU targets with least-cost for EU citizens based on efficient & effective policy mixes.

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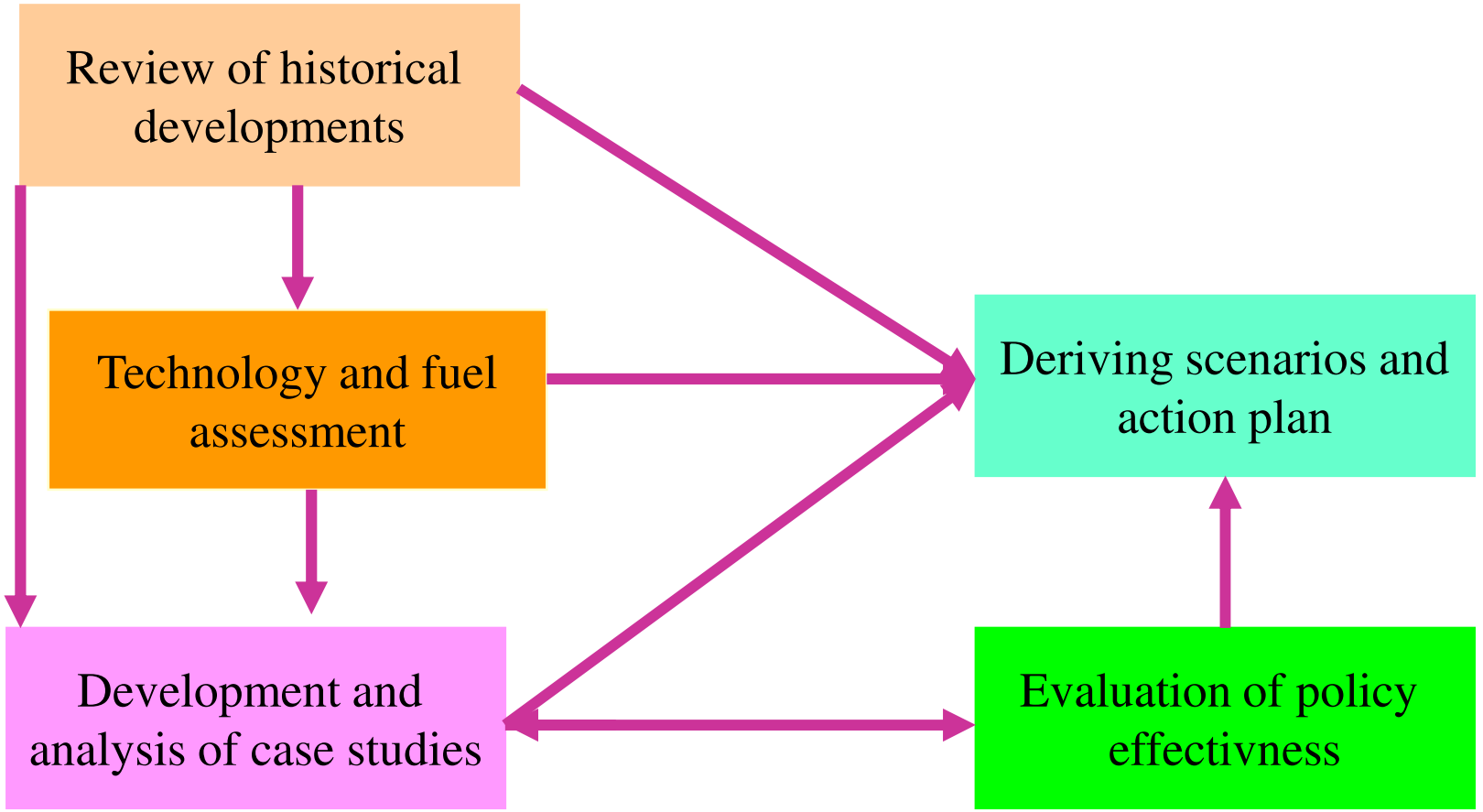
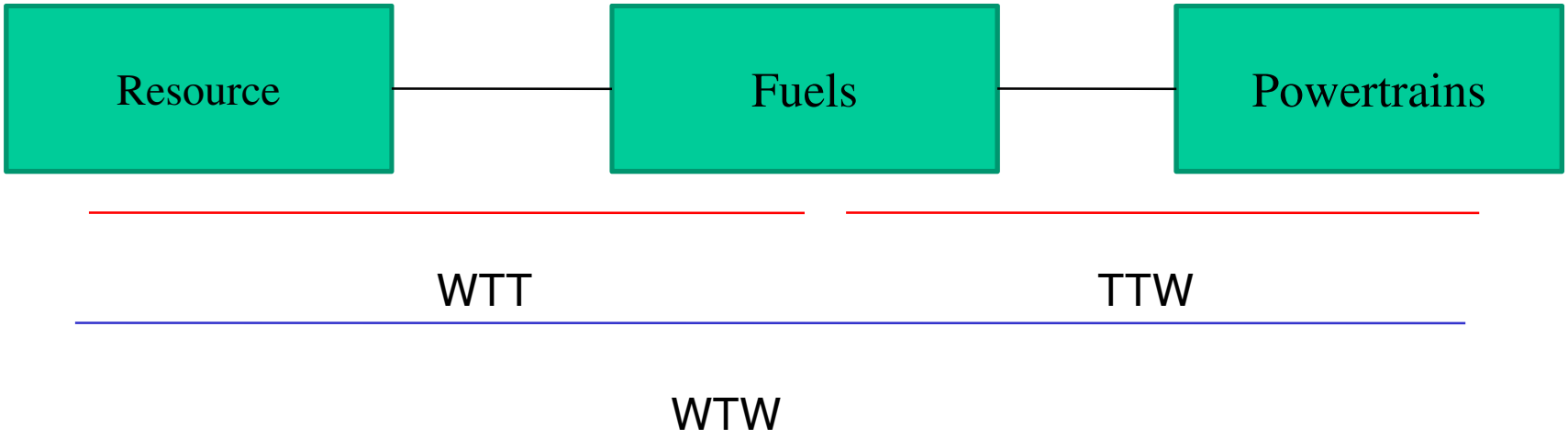
Intelligent Energy Europe

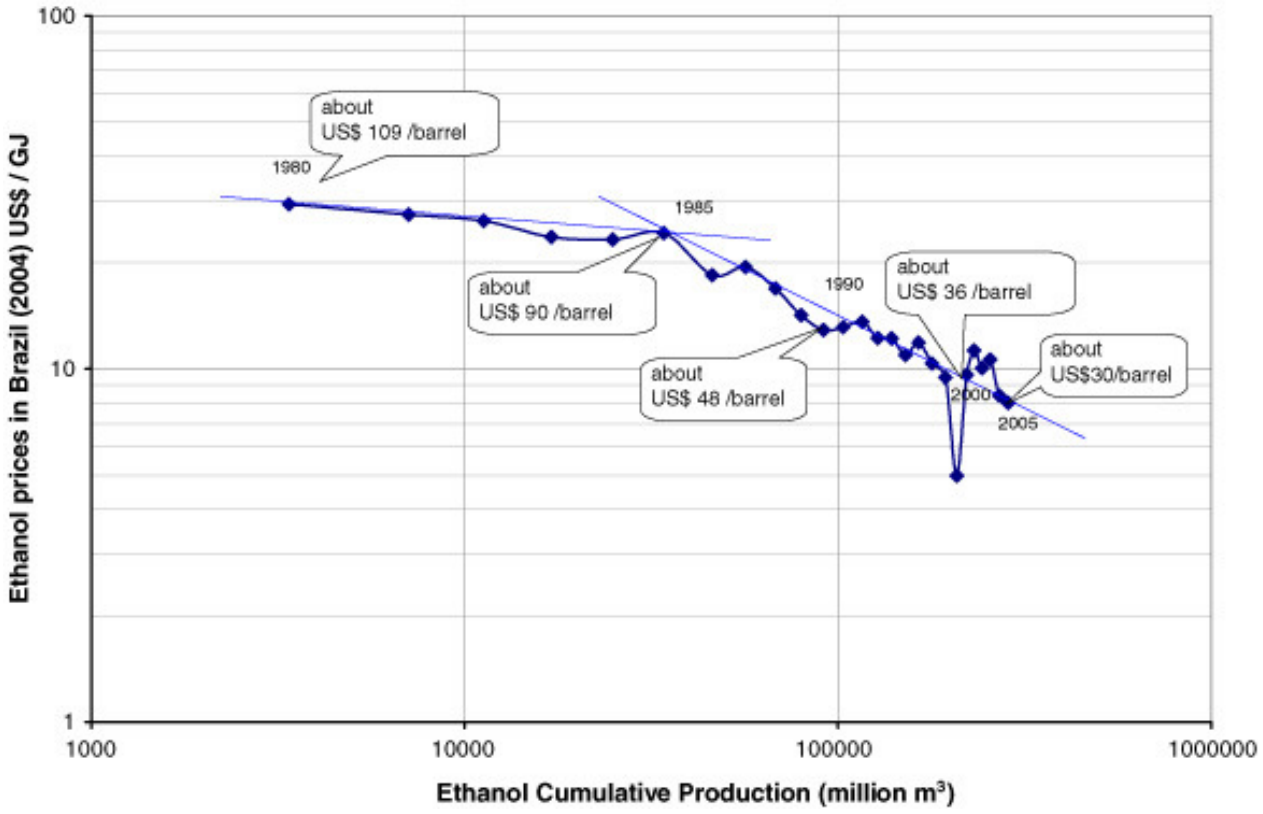

Review of historical developments
Technology and fuel assessment
Development and analysis of case studies
Deriving scenarios and action plan
Evaluation of policy effectivness

Economic analysis



✓Fuel costs (€/l)
✓ Investments costs (€/vehicle)
✓ Mobility costs (€/km)

Economic analysis



$$C(x) = a \cdot x^{-b}$$

C(x): Specific cost
x: Cumulative capacity
b: Learning index
a: Specific cost of the first unit

$$p = 2^{-b}$$

P: progress ratio

Technology learning curves

Economic analysis

Biofuels costs (BFC) :

$$BFC = FC + ACC - Sub$$

Net feedstock costs :

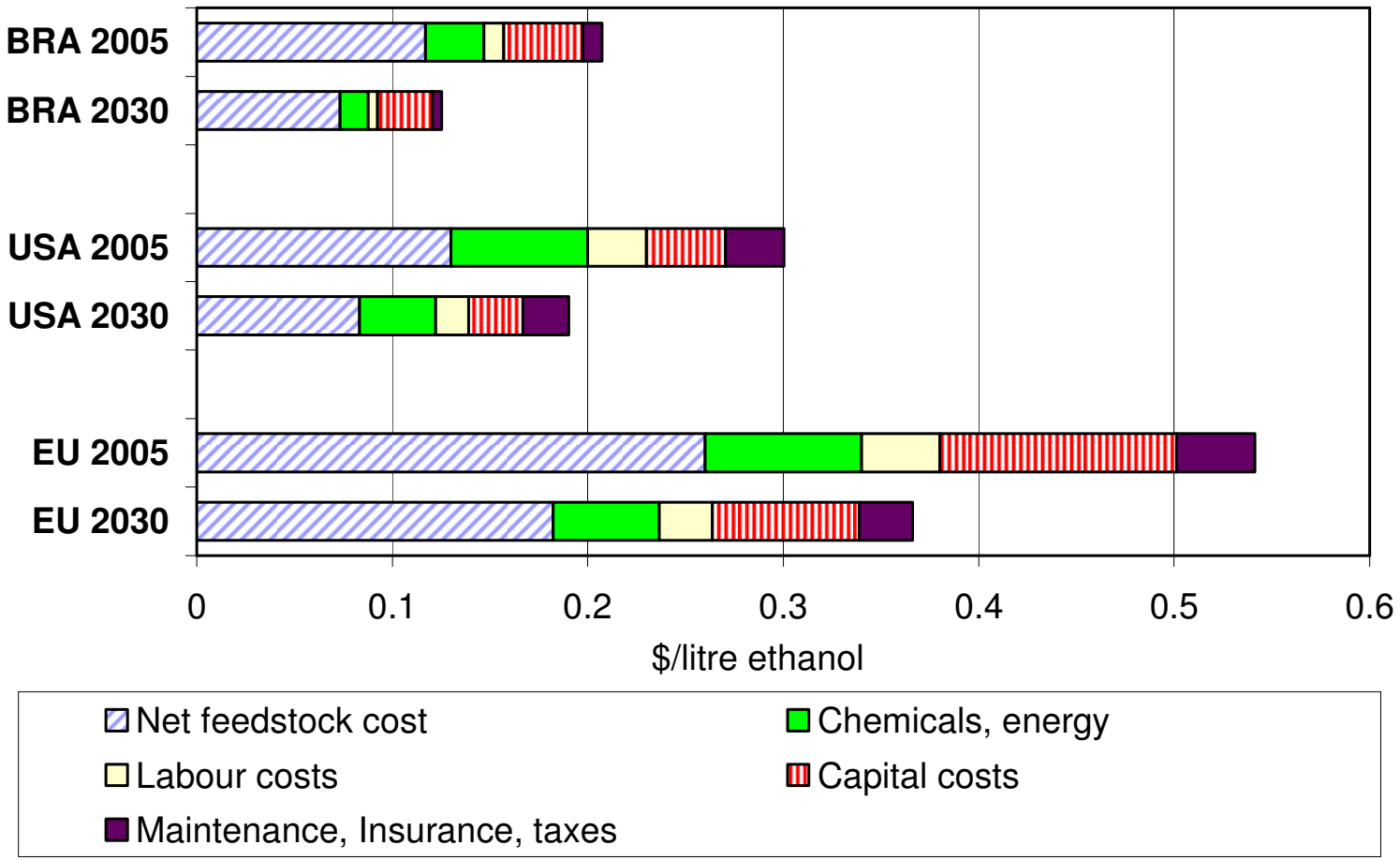
$$FC = FP - ASub - C_{by-product}$$

Average gross conversion costs:

$$ACC = CC + O\&M$$

$$CC = SC * CRF$$

Economic analysis



Cost structure of bioethanol

Economic analysis

Total vehicle costs:

$$IC = IC^{CON} + IC^{INNOV}$$

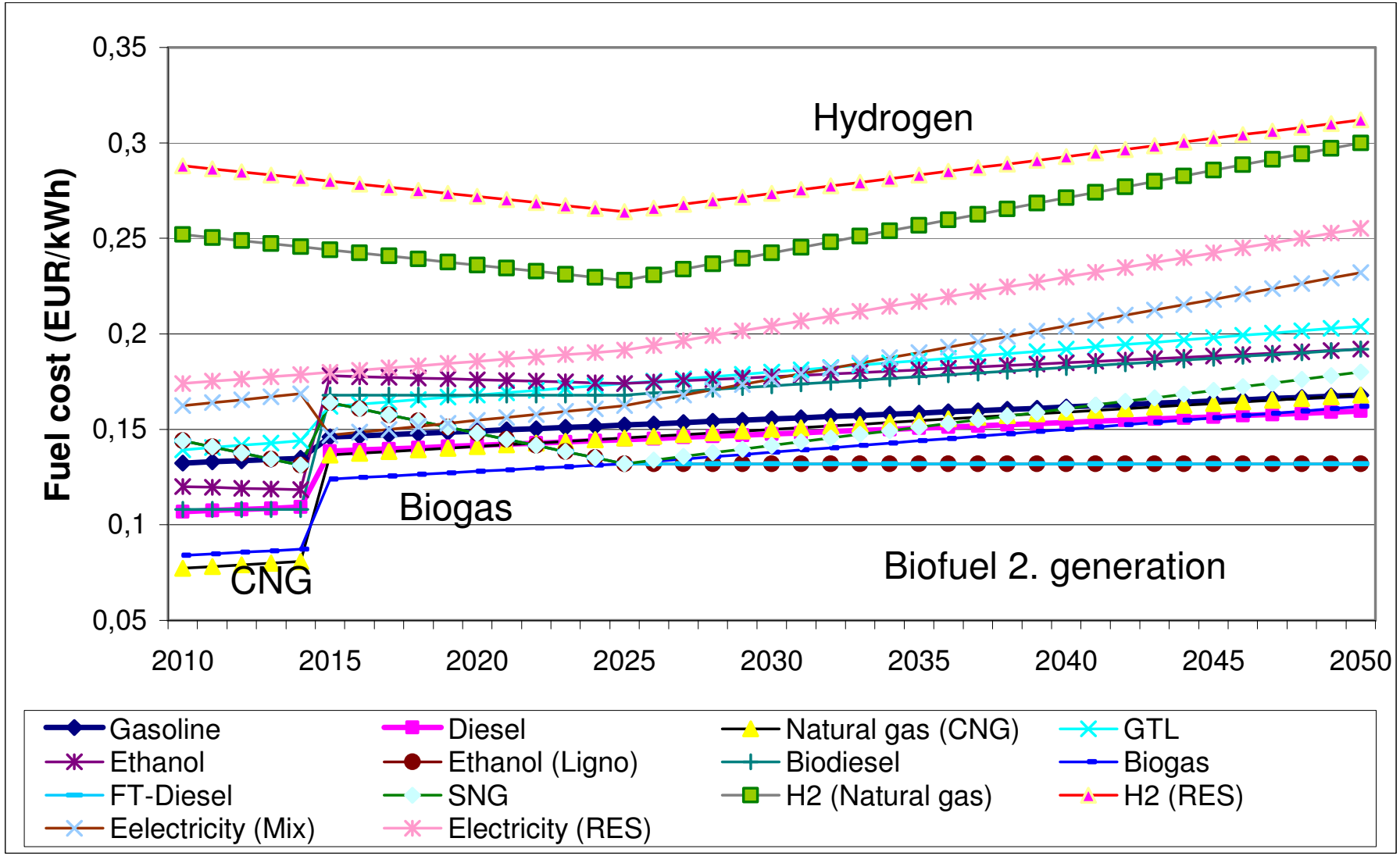
The total transport costs:

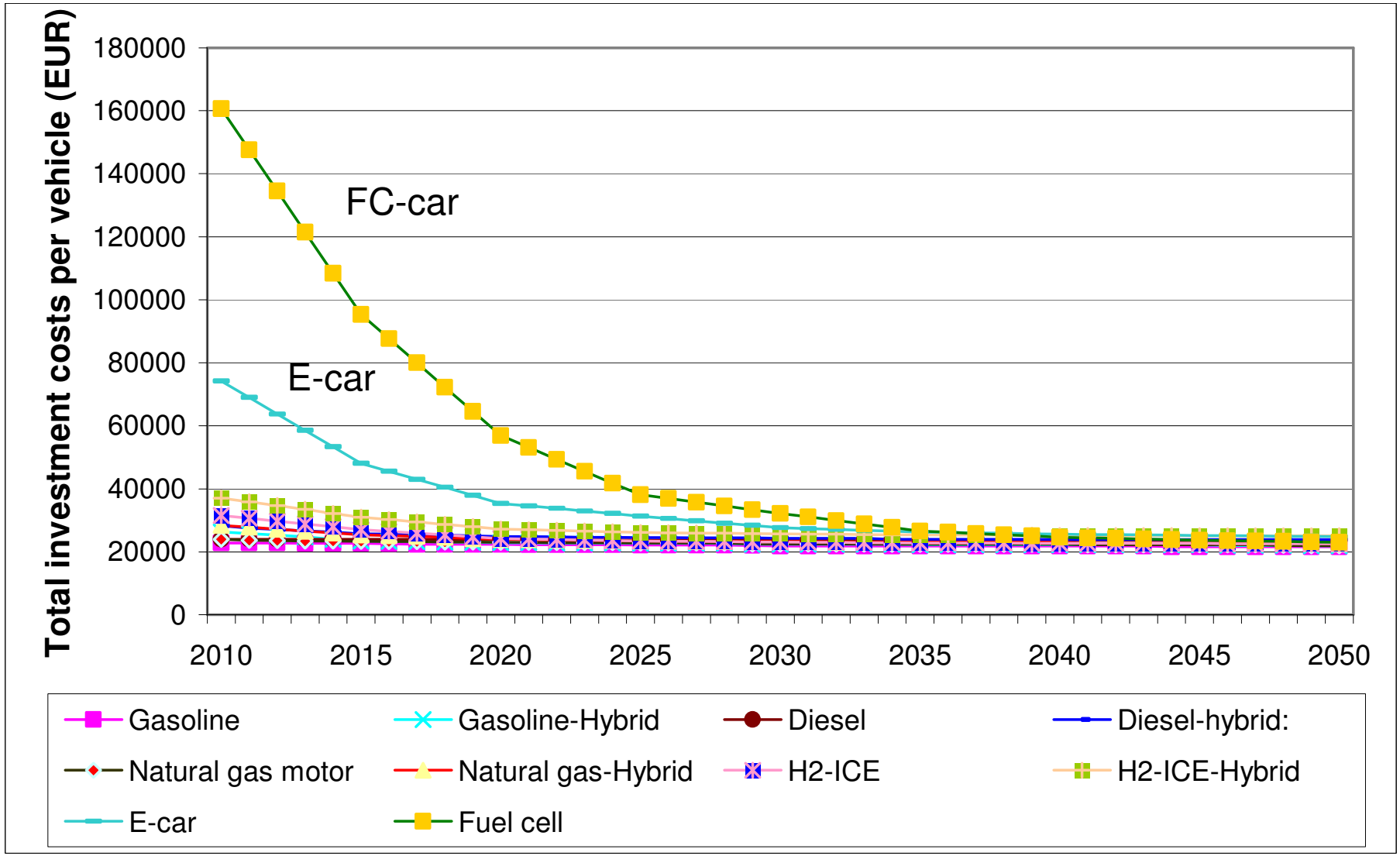
$$TC = FC + IC_{sp}$$

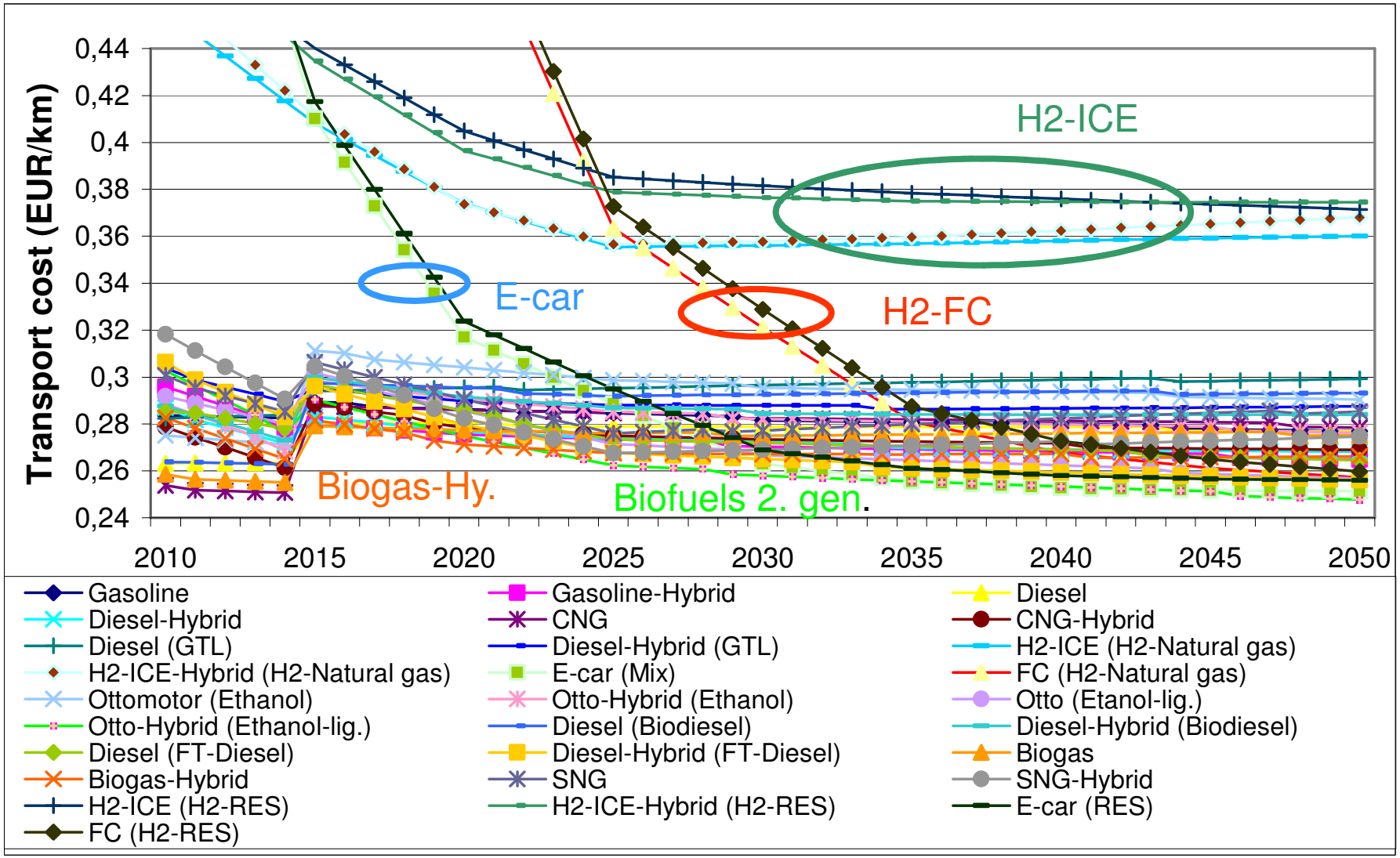
$$IC_{sp} = (\alpha \cdot (IC + NOVA) \cdot (1 + VAT)) / D_{km}$$

The fuel cost per kilometre:

$$FC = EC \cdot FP$$


Fuel cost (EUR/kWh)
0,35
0,3
0,25
0,2
0,15
0,1
0,05
2010
2015
2020
2025
2030
2035
2040
2045
2050
Hydrogen
Biogas
CNG
Biofuel 2. generation
Gasoline
Diesel
Natural gas (CNG)
GTL
Ethanol
Ethanol (Ligno)
Biodiesel
Biogas
FT-Diesel
SNG
H2 (Natural gas)
H2 (RES)
Eelectricity (Mix)
Electricity (RES)


Total investment costs per vehicle (EUR)
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
2010
2015
2020
2025
2030
2035
2040
2045
2050
FC-car
E-car
Gasoline
Gasoline-Hybrid
Diesel
Diesel-hybrid:
Natural gas motor
Natural gas-Hybrid
H2-ICE
H2-ICE-Hybrid
E-car
Fuel cell


Transport cost (EUR/km)
0,44
0,42
0,4
0,38
0,36
0,34
0,32
0,3
0,28
0,26
0,24
2010
2015
2020
2025
2030
2035
2040
2045
2050
H2-ICE
E-car
H2-FC
Biogas-Hy.
Biofuels 2. gen.
Gasoline
Gasoline-Hybrid
Diesel
Diesel-Hybrid
CNG
CNG-Hybrid
Diesel (GTL)
Diesel-Hybrid (GTL)
H2-ICE (H2-Natural gas)
H2-ICE-Hybrid (H2-Natural gas)
E-car (Mix)
FC (H2-Natural gas)
Ottomotor (Ethanol)
Otto-Hybrid (Ethanol)
Otto (Etanol-lig.)
Otto-Hybrid (Ethanol-lig.)
Diesel (Biodiesel)
Diesel-Hybrid (Biodiesel)
Diesel (FT-Diesel)
Diesel-Hybrid (FT-Diesel)
Biogas
Biogas-Hybrid
SNG
SNG-Hybrid
H2-ICE (H2-RES)
H2-ICE-Hybrid (H2-RES)
E-car (RES)
FC (H2-RES)

Energy Economics Group

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Thank you!

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